ESO 424

# THE FEASIBILITY OF MARKETING TEMPERATE CROP FRUITS & VEGETABLES IN THE HIGHLANDS OF GUATEMALA, C.A.

- A CASE STUDY -

by

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Guatemala Small Farmer Marketing Project

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# PREFACE

This paper is one of a series examining the feasibility of a small farmer fruit and vegetable marketing project in the highlands of Guatemala. Other papers examine organizational needs, sociological aspects, environmental impact, production costs and returns, exports and market structure.

Small farmers are defined as those having farms of less than 5 hectares. Their location is in the central highlands where the elevation ranges from 5,000 feet to 14,000 feet. This elevation provides a year around temperate climate where fruits and vegetables produced are similar to those produced in the U.S. midwest, even though Guatemala is located in the range of 14 degrees N to 16 degrees N (somewhat south of the latitude of Cuba).

The farmers in the highlands area are typically Indian. The family income in the rural area is about $180 per year. Labor rates outside Guatemala City are $1.25 to $1.50 per day. In most areas, crops can be grown almost all year if irrigation is used. The use of irrigation is not common. The rainy season for much of this area extends from May to October.

The main food crop grown in this area is corn. The Indian feels he must grow corn for religious reasons and for survival. Corn is a subsistence crop and is mostly consumed at home. More wheat is being grown, and marketed, under a government protected price ($10 per hundredweight), and more bread is being consumed.

Generally, fruit and vegetable crops are cash crops for these farmers. Markets for these crops are highly fragmented with very limited market information available. This paper examines prospects for establishing market facilities which would make marketing more accessible to these farmers on a continuing basis while providing a source of market information. Vegetable crops are commonly

grown on small plots, and there is rarely any form of mechanization for any farm activity on these Indian farms.

The unit of currency is the quetzal, which, for over 50 years, has had a value equal to the U.S. dollar. Quetzales and dollars are used interchangeably in this paper.

One of the problems faced by a market analyst when considering the feasibility of new market facilities and organizations in developing countries is a lack of data on production, on present market structure, on marketing margins, on farm, wholesale and retail prices, on price cycles and on price cycles and on market losses. Census data in Guatemala aggregates most fruit and vegetable crop production information into a classification of "other crops."

The Guatemala terminal market is the focal point of marketing fruit and vegetable crops, both for domestic consumption and for export sales to nearby Central American countries, principally El Salvador. Interviews with buyers and sellers at the terminal market can establish farm, wholesale and retail prices. This information, when carefully gathered and aggregated, can establish estimates of marketing loss for each crop. For example, as the cabbage crop proceeds through the marketing channels, normal margins at each stage can be identified. The total of the margins, when added to average farm price, should approximate retail price if no marketing loss occurs. Any substantial difference between observed retail prices and calculated retail prices may be marketing loss. Additional evidence on marketing loss may be verified by observing where the greatest losses occur. This interviewing process can also locate major production areas in the country and establish when these crops come to market.

The interviewing process then may be carried to the local country markets in the major production areas and to representative farmers in each area to check transportation costs, farm, wholesale and retail prices at these various locations,

production cycles, and to identify perceived marketing problems faced by farmers.

When information on each crop is disaggregated by local market areas, these data can be recombined into geographical areas where market facilities and organizations are being considered.

In Guatemala, local farmer cooperatives provide an important source of information relative to crops produced and marketing problems faced by farmers; although their members produce only a small percentage of temperate crop fruits and vegetables. Many of the local cooperatives are members of one of three cooperative federations. One of the national federations'(FENACOAC) programs is concentrated on providing credit, one (FECOAR) on providing agricultural inputs, and one (FEDECOAG) on services such as credit unions and grain marketing. The federations have been involved in several marketing projects, all of which have resulted in financial losses because of a lack of market contacts, management, and a limited knowledge about storage, supply and demand conditions and other marketing activities.

Extension services and research from government sources on fruits and vegetables are very limited. The most effective extension work with farmers is provided by cooperatives. Most of the cooperatives extension work in the highlands area is concentrated on corn and wheat.

As interviews gathered information relative to the feasibility of market facilities, several concerns became apparent:

1. How does the small farmer really feel about selling in the present Guatemala City terminal market?
2. How near to the present terminal market can a small farmer sub-assembly facility be located?
3. Will this (or these) market facility be "dropped upon" a market area? Will small farmer leaders be involved in the planning/advising process?

4. Can market participation be kept open to all small farmers (rather than present coop members?)
5. Is the proposed market facility only for small farmers?
6. Will small farmers delivery a quality product for a quality pack?
7. What combination of sub-assembly, sales points and information services is desirable and manageable?
8. How many different commodities can one set of facilities and one management most effectively handle? Multi-product grading and packing plants problems grow rapidly as the number of different kinds of crops handled increases.
9. How do market facilities proposed best fit the Guatemalan situation involving those in the present marketing system, while not developing antagonisms which could present major problems to a new organization? This involves integrating the project into the present marketing system without adding direct costs of marketing at the expense of farm income, while insuring the financial viability of the project. At the same time, the project should have potential for implementing change in the present marketing system while increasing farm income, smoothing seasonal price and supply patterns, and improving the quality of the product when it reaches the consumer's hands.
10. Of some concern is the undertainty of the degree that differing levels of quality are perceived and paid for by buyers in the wholesale market and by consumers at retail.

To better understand some of these concerns, see Jelinek's report on Institutional and Organizational Analysis in the appendix.

An additional consideration is this project, if feasible, will be funded by USAID (U.S. Agency for International Development). Some of the funds provided will be loans channeled through BANDESA, the Government of Guatemala agricultural

bank. These loan funds will be allocated primarily for buildings, equipment and other tangible assets. In addition, grant funds will support the marketing activity and be used for organizational support, management training and technical assistance.

The support of the present leadership of the cooperative federations and the local cooperatives is a necessary ingredient to the success of this project because of their former contracts. The federation leadership feels that financing should be channeled through the existing cooperatives rather than used to establish a new cooperative which they view as a possible future competitor (for credit and farm inputs). On the other hand, the present federations are not enthusiastic about opening participation fully to those farmers who are not now cooperative members. Outside cooperative consultants have serious reservations about the present cooperatives having management control over a fruit and vegetable marketing group. Thus, the organizational structure for this project is as critical a question for this project as the financial feasibility which this report primarily addresses.

Because of the restrictions of time, several questions raised in this report were not addressed. For example, when identifying the location and size of the Guatemala City facility, a strong possibility exists that a facility in the terminal market area may have to be located in an older, renovated leased building because of obstacles of obtaining sufficient land in this area to construct and service a new building in this congested, high priced area. The report does not explore this alternative and it's consequences on capital required, on cash flow and on acceptance of this alternative by U.S. Aid.

This report does indicate, however, the marketing project is economically viable given the support of present cooperative leadership and adequate management capability of the marketing organization.

CONTENTS

## SUMMARY

Market facilities to receive, size, grade and pack fruits and vegetables growing in the altiplano are recommended. A management sales and coordinating office would be located at or near the terminal market in Guatemala. Four regional markets would receive farmer's crops and perform necessary grading and packing functions.

These four regional markets would be similar in function and layout, but different in size, due to production variations between regions. All would have short-term storage space, both refrigerated and unrefrigerated. All would have some simple grading equipment designed for the crops of that area.

One regional would be near Huehuetenango and serve farmers at that area. The principal crops to be handled would be garlic, onions, carrots and apples. This facility would be 25 M x 40 M.

A second regional would be located near Quezaltenango, and would serve farmers in San Marcos, Quezaltenango, and Totonicapan. Principal crops to be handled would be onions, cabbage, potatoes, carrots, beets, chard, cauliflower, peaches and apples. This facility would be 25 M x 60 M.

A third regional would be in the Tecpan area, and would serve farmers in the Tecpan, Solola, and Quiche areas. Principal crops to be handled would be garlic, onions, cabbage, potatoes, carrots, beets, turnips, radishes, chard, cauliflower, lettuce and avocadoes. This facility would be 25M x 60 M.

A fourth facilty would be located in Guatemala near the Terminal, and would serve farmers in Guatemala and Sacatepequez. This facility would also receive shipments from other regionals and act as an assembly and distribution point for the system. The principal crops handled would be tomatoes, onions, beets, cabbage, potatoes, carrots, radishes, chard, cauliflower, lettuce, and avocados. This facility would be 25 M x 81 M.

The facilities are sized to meet the needs of the year 1982-83. The organization would not own the trucks for transporting fruits and vegetables, but would contract this function.

The capital budget for facilities and equipment totals $1,385,000. A loan of $1.5 million is suggested. An additional $900,000 of support money for operational training start-up, training and technical assistance would be needed.

This operation would begin in 1978-79, would have operating losses the first two years, break even the third year, and reach full operating potential the fifth year (1982-83), returning over 20% on investment that year.

For the Future:

The present cooperative federations, local cooperatives and many farmers are interested in storage. This program will be limited initially to four commodities; garlic, onions, potatoes and apples. Storage, in this context, is seasonal, or intermediate term, and is differentiated from holding the product for a few days to smooth over temporary supply and price problems.

When the fresh market systems described above is fully operational in 1980-81 (third year), plans should be implemented to build and operate:

Potato Storage; 1 in Tejutla, 1 in Quezaltenango.

Garlic Storage; 1 in Huehuetenango.

Onion Storage; 1 in Solola, 1 in Quezaltenango.

Apples Storage; 1 in San Juan Ixcoy/Saloma, 1 in Quezaltenango.

The estimated site and building cost for this program is $900,000. An additional $900,000 for management, inventory, and technical support will be required. Much of this $900,000 will be required to finance the inventory.

Processing:

Studies of processing opportunities should continue. With marketing facilities and storage in place, quantities of product essential to a processing operation may be within reach. Continuing studies should concentrate on those products which offer both Central American export and domestic Guatemalan consumption possibilities, but not rule out other export outlets. Processing was put in a secondary position at this time because all processing plants in Guatemala are now operating at 50% capacity or less. With assembly facilities and storage and expanded production, specialized processing operations may become more feasible.

At this time, preparations should be made for investments at about $1.5 million in processing in the 1982-83 period. It is estimated that additional support money of about the same amount will be required for inventory, management training and technical assistance.

# GUATEMALA SMALL FARMER FRUIT & VEGETABLE MARKETING

## MARKET ANALYSIS

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When making decisions on improving a marketing system, ultimately recommendations must center upon making changes in the present system. These changes may relate to providing more and better market information, reorganizing the present structure, improving market performance of those in the present system, improving storage and transportation, improving price efficiency of the system, reducing shrink wherever loss is excessive, improving quality maintenance throughout the system, and developing more efficient physical facilities where they are needed.

Recommendations for change should take into account agricultural products produced, seasonality of production, need for storage for less perishable crops, relative profitability of crops produced, transportation inefficiencies, pricing inefficiencies, marketing losses, equity questions for producers, those in the marketing system and consumers, as well as quality improvement, meeting needs of export market and cultural and social patterns which can have major effects on production, marketing and consumption of food in Guatemala.

All of these influences come to bear upon alternatives related to establishing new market facilities. This report will concentrate on questions about location, size and function of new market facilities which have potential for increasing the income of small farmers in the highlands area of Guatemala.

Observations by Watkins, Steele, Jelinick, Godwin[1/] and in-country marketing people have indicated inefficiencies in assembling fresh fruit and vegetable crops from the point of production to the centers of population where the distribution

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Howard Steele, Foreign Development Div., Economic Research Service, USDA
Dwayne Jelinick, Marketing Consultant, USDA (Mountain West Research, Inc.)
Marshall R. Godwin, Deputy Administrator, Farmers Coop. Service, USDA

function towards consumers begins. These inefficiencies are related to product handling, and to total time committed by producers and sub-assemblers (truckers and village markets) to market small quantities. There are also indications of pricing inefficiencies which lead to wide price variations over short time spans for some of the fruit and vegetable crops. Two areas, then, seem to appear as prime subjects for further investigation:

1) The location and size of market facilities for crops for which there is a volume of production.
2) The improvement of market information to farmers, including price, quantities, and quality characteristics.

These two areas of concern can be integrated into one marketing approach.

The procedure for analyzing the marketing of the identified fruits and vegetables from the highlands of Guatemala follows:

## Market Analysis

1. Identify crops (fruits and vegetables) which are of some importance or which have potential for increasing farmers' income.
2. Locate major production areas for these fruits and vegetables.
3. Identify value of crop and tonnage of crops in major production areas.
4. Identify the major production areas and the major consumption areas where tonnage appears to have a potential volume sufficient for considering an assembly point or some other market facility.
5. Choose the crops in each major production marketing area that have potential for improving the market performance of that commodity through assembly, grading, transportation, storage, packaging or pricing activities of a market facility.
6. Estimate the market share that is obtainable of the total marketings from an

area for the crops identified.

7. Determine the size of each facility needed and the equipment needed to fulfill the marketing functions identified for each crop to be handled.
8. Identify and analyze capital requirements and operating costs for market facilities and services identified.
9. Determine benefits and revenues accruing to, and because of, added market facilities and services.
10. Recommend action based on capital requirements and operating costs compared with benefits and revenues derived.
11. If recommended action is for developing market facilities, choose the site or sites for the facilities.
12. Develop detailed plans for organization of farmers and market operations.

## Crops to be Considered

Crops which are considered for inclusion in the Small Farmer Fruit and Vegetable Marketing Project are identified in Table 1. The consideration of marketing facilities for some 20 vegetables and 8 fruits is rather complex and perhaps even hazardous. Typically, an assembly point specializes in a very limited number of crops. This is because of varying requirements of each crop related to: handling procedures, perishability characteristics, packaging needs, transportation requirements and storage temperature and humidity optimums.

A strong recommendation, therefore, would be to select those crops which are marketed in sufficient volume to achieve efficiencies in marketing and which have at least some common transportation, perishability and storage characteristics that would permit common use of a marketing facility.

Information about the 20 vegetable and 8 fruit crops is contained in Table 2. This information is derived from the production cost estimates of Gonzalez and the

price and margin analyses by Garcia and Steele.[2/]

The yield per hectare is considered one that can realistically be achieved by small farmers in the altiplano at the present time. Prices per metric ton are averages that farmers receive over the marketing season. The hectarage is derived from average yields and metric tons of production. The farm net income per hectare is taken from Gonzalez enterprise analyses completed this year as part of this marketing project. The total gross farm income is calculated from metric tons of production and price per metric ton.

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2/ See Annex 2, 4 and 5 for details.

TABLE 1

GUATEMALA SMALL FARMER MARKETING IMPROVEMENT PROJECT - 1976

List of Temperate Fruits and Vegetables of Interest

| A. Fruits | Fruitas |
|---|---|
| 1. Apple | 1. Manzana |
| 2. Avocado | 2. Aguacate |
| 3. Blackberry | 3. Zarzamora or Mora |
| 4. Peach | 4. Durazno or Melocoton |
| 5. Pear | 5. Pera |
| 6. Plum | 6. Ciruela |
| 7. Raspberry | 7. Frambuesa |
| 8. Strawberry | 8. Fresa |

| B. Vegetables | Hortalizas | Vegetables | Hortalizas |
|---|---|---|---|
| 1. Asparagus | 1. Esparrago | 11. Garlic | 11. Ajo |
| 2. Beet | 2. Remolacha | 12. Green Beans | 12. Ejote |
| 3. Broccoli | 3. Broculi o Brecol | 13. Lettuce | 13. Lechuga |
| 4. Brussel Sprouts | 4. Bretones | 14. Onion | 14. Cabolla |
| 5. Cabbage | 5. Rapollo | 15. Peas | 15. Arveja |
| 6. Carrot | 6. Zanahoria | 16. Potato | 16. Papa |
| 7. Cauliflower | 7. Coliflor | 17. Radish | 17. Rabano |
| 8. Celery | 8. Apio | 18. Spinach | 18. Espinaca |
| 9. Chard | 9. Acelga | 19. Tomato | 19. Tomate |
| 10. Cucumber | 10. Pepino | 20. Turnip | 20. Nabo |

TABLE 2

GUATEMALA HIGHLAND VEGETABLE/FRUIT PRODUCTION, 1975

| | Production M.T. | Yield Per Hectare M.T. | Average Return per M.T.$ | Hectares | Farm Net $ per Hectare | Total Gross Farm Income |
|---|---|---|---|---|---|---|
| Potatoes | 25,962 | 13.0 | 130 | 1,997 | 515 | 3,375,060 |
| Carrots | 15,450 | 20.0 | 167 | 773 | 709 | 2,580,150 |
| Cabbage | 27,191 | 21.2 | 83 | 1,283 | 296 | 2,256,853 |
| Cauliflower | 9,602 | 15.5 | 160 | 619 | 976 | 1,536,320 |
| Chard | 8,672 | 13.9 | 300 | 624 | 835 | 2,601,600 |
| Beets | 5,140 | 17.1 | 227 | 301 | 682 | 1,166,780 |
| Onions | 9,002 | 17.0 | 75 | 530 | 314 | 676,150 |
| Lettuce | 5,692 | 16.46 | 182 | 345 | 753 | 1,035,944 |
| Garlic | 4,815 | 6.3 | 445 | 764 | 715 | 2,142,675 |
| Green Beans | 5,058 | 10.0 | 250 | 506 | 184 | 1,264,500 |
| Radishes | 3,704 | 6.6 | 336 | 561 | 463 | 1,244,454 |
| Tomatoes | 14,381 | 28.0 | 75 | 594 | 525 | 1,078,575 |
| Peas | 2,209 | 4.2 | 235 | 526 | 204 | 519,115 |
| Cucumbers | 715 | 8.5 | 212 | 84 | 646 | 151,580 |
| Turnips | 1,582 | 13.2 | 167 | 120 | 494 | 264,194 |
| Spinach | 1,364 | 10.0 | 230 | 136 | 835 | 313,720 |
| Celery | 793 | 11.0 | 335 | 72 | 876 | 265,655 |
| Brussel Sprouts | 54 | 13.5 | 66 | 4 | 144 | 3,564 |
| Broccoli | 80 | 16.0 | 175 | 5 | 908 | 14,000 |
| Asparagus | 16 | 2.2 | 1,300 | 7 | 933 | 200,800 |
| [illegible] | 625 | 12.7 | 360 | 49 | 2,018 | 225,000 |
| Peaches | 1,300 | 19.8 | 400 | 66 | 2,160 | 520,000 |
| Berries | 106 | 15.0 | 450 | 7 | 2,600 | 47,700 |
| Apples | 2,827 | 18.2 | 460 | 155 | 2,615 | 1,300,420 |
| Pears | 928 | 18.0 | 400 | 52 | 3,178 | 371,200 |
| Avocadoes | 14,600 | 30.0 | 40 | 487 | 250 | 584,000 |

## Location of Population

Before proceeding to disaggregate production data, some estimate of where the consuming population lives in the country should be explored. Table 3 identifies the population of Guatemala by Departments and Municipios. Details include the size of the geographical area, the urban population, the rural population, and the population density as measured by population per square kilometer. Seven departments have a population density of about 100 persons per square kilometer or more. These seven departments account for 46 percent of the total population, and should be considered as locations for any market facility which is developed to better service the consumer, should such a market facility be needed to improve total market performance.

If market facilities to better serve the consumer do appear feasible as a means of increasing small farmers' income, then a much more thorough analysis of this final step in marketing food needs to be made.

TABLE 3

GUATEMALA 1973 POPULATION

| [illegible] | Km² | Urban | Rural | Total | Habutantes per Km² |
|---|---|---|---|---|---|
| La Republic | 108,889 | 1,752,495 | 3,459,434 | 5,211,929 | 48 |
| Guatemala | 2,126 | 799,271 | 328,574 | 1,127,845 | 530 |
| El Progresso | 1,922 | 16,700 | 56,476 | 73,176 | 38 |
| Sacatepequez | 465 | 71,556 | 28,154 | 99,710 | 214 |
| Chimaltenango | 1,979 | 67,288 | 126,269 | 193,557 | 98 |
| Escuintla | 4,384 | 93,022 | 207,118 | 300,140 | 68 |
| Santa Rosa | 2,955 | 38,453 | 137,745 | 176,198 | 60 |
| Solola | 1,061 | 40,914 | 85,970 | 126,884 | 120 |
| Totonicapan | 1.061 | 24,820 | 141,802 | 166,622 | 157 |
| Quezaltenango | 1.851 | 108,750 | 202,863 | 311,613 | 160 |
| Suchitepequez | 2,510 | 64,098 | 147,919 | 212,017 | 84 |
| Retalhuleu | 1,856 | 38,831 | 95,162 | 133,993 | 51 |
| San Marcos | 3,791 | 49,553 | 338,547 | 388,100 | 102 |
| Huehuetenango | 7,400 | 58,167 | 310,640 | 368,807 | 50 |
| Quiche | 8,378 | 30,835 | 269,806 | 300,641 | 36 |
| Baja Verapaz | 3,124 | 22,687 | 84,222 | 106,909 | 34 |
| Alta Verapaz | 8,686 | 34,740 | 241,630 | 276,370 | 32 |
| Peten | 35,854 | 20,448 | 44,055 | 64,503 | 2 |
| Izabel | 9,038 | 29,566 | 141,298 | 170,864 | 19 |
| Zacapa | 2,690 | 30,551 | 76,175 | 106,726 | 40 |
| Chiquimula | 2,376 | 35,855 | 122,313 | 158,146 | 67 |
| Jalapa | 2,063 | 32,673 | 85,430 | 118,103 | 57 |
| Jutiapa | 3,219 | 43,739 | 187,266 | 231,005 | 72 |

## Location of Production

Table 4 contains information that allocates production of the temperate fruit and vegetable crops in the altiplano by geographical areas in terms of percentage of the total crop. This information has been recombined into possible market areas to examine the tonnage and value of these crops by market areas.

Four areas have been identified as having a production base that would provide volume for a market facility (sub-assembly, grading, packaging, shipping point or distribution point):

1) The Huehuetenango market area

2) The San Marcos, Quezaltenango, Totonicapan market area

3) The Tecpan, Solola, Quiche market area

4) The Guatemala market area, including Sacatepequez

Tables 6 through 9 provide estimates of crops produced in each of these areas with the tonnage produced and farm value of that production. Also indicated is the share of the total production that is produced in each of these market areas.

Table 4

TEMPERATE CROP PRODUCTION --GUATEMALA--1975-- PRODUCTION BY GEOGRAPHICAL AREAS--PERCENT OF TOTAL CROP*

| | Chimaltenango | | | Guatemala | | | | | | | | Huehuetenango | | | Quezaltenango | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tejar | Comalapa | Others | San Jose Pinula | Amatitlan | Palencia | Villa Nueva | Barcenas | Villa Canales | Others | Sacatepequez | Chiantla | Aguacatan | Others | Almolonga | Zunil | Others | San Marcos | Solola | Totonicapan | Quiche | Rest of Country |
| Tomatoes | 1.0 | 1.0 | --- | 3.0 | 2.0 | 3.0 | 2.0 | 2.0 | 2.0 | --- | --- | --- | --- | .2 | --- | --- | --- | .1 | --- | --- | .2 | 83.7 |
| Onions | 2.0 | 2.0 | --- | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 0.6 | 4.0 | 2.5 | 3.0 | --- | 11.0 | 11.0 | 1.0 | --- | 4.5 | --- | .5 | 49.0 |
| Cabbage | 7.0 | 7.0 | 2.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 0.6 | 16.0 | --- | --- | --- | 4.0 | 4.0 | 4.0 | 36.0 | 12.0 | --- | --- | --- |
| Potatoes | 3.0 | 3.0 | 2.0 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 0.6 | 3.0 | 4.0 | 4.0 | --- | 2.5 | 2.5 | 3.0 | 20.0 | 4.0 | 2.0 | .8 | 13.0 |
| Carrots | 15.0 | 15.0 | --- | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | --- | 10.0 | 5.0 | 4.0 | --- | 5.0 | 5.0 | --- | 22.0 | 8.0 | 1.0 | --- | --- |
| Garlic | 5.0 | 5.0 | --- | 4.0 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | --- | --- | 30.0 | 40.0 | --- | 1.0 | 4.0 | --- | --- | 5.0 | --- | --- | --- |
| Beets | 13.0 | 12.0 | --- | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | --- | --- | 25.0 | --- | --- | --- | 10.0 | 8.0 | --- | 7.0 | 15.0 | --- | --- | --- |
| Radishes | 10.0 | 10.0 | --- | 5.0 | 4.0 | 4.0 | 3.0 | 2.0 | 2.0 | --- | 20.0 | --- | --- | --- | 7.0 | 6.0 | --- | 23.0 | 4.0 | --- | --- | --- |
| Turnips | 18.0 | 17.0 | --- | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | --- | 35.0 | --- | --- | --- | --- | --- | --- | --- | 20.0 | --- | --- | --- |
| Celery | 17.0 | 16.0 | --- | --- | --- | --- | --- | --- | --- | --- | 33.0 | --- | --- | --- | 20.0 | 14.0 | --- | --- | --- | --- | --- | --- |
| Chard | 10.0 | 10.0 | --- | --- | --- | --- | --- | --- | --- | --- | 40.0 | --- | --- | --- | 25.0 | 14.0 | --- | --- | --- | --- | --- | --- |
| Cucumbers | --- | --- | --- | 3.0 | 3.0 | 3.0 | 2.0 | 2.0 | 2.0 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | 85.0 |
| Green Beans | 8.0 | 8.0 | 4.0 | 3.9 | 3.9 | 2.9 | 2.9 | 2.9 | 2.9 | 0.6 | 20.0 | --- | --- | --- | 8.0 | 8.0 | 4.0 | --- | 20.0 | --- | --- | --- |
| Cauliflower | 14.0 | 14.0 | 2.0 | --- | --- | --- | --- | --- | --- | --- | 30.0 | --- | --- | --- | 5.0 | 5.0 | --- | 30.0 | --- | --- | --- | --- |
| Lettuce | 5.0 | 5.0 | --- | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | --- | 40.0 | --- | --- | --- | 15.0 | 15.0 | --- | --- | --- | --- | --- | --- |
| Spinach | 5.0 | 5.0 | --- | --- | --- | --- | --- | --- | --- | --- | 30.0 | | | | 15.0 | 15.0 | --- | --- | 30.0 | --- | --- | --- |
| Peas | 23.0 | 22.0 | --- | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | --- | 35.0 | --- | --- | --- | 3.0 | 2.0 | --- | 15.0 | --- | --- | --- | --- |
| Asparagus | | | | | | | | | | | | | | | | | | | | | | |
| Broccoli | 10.0 | 10.0 | --- | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 | --- | 20.0 | --- | --- | --- | 10.0 | 10.0 | --- | --- | 20.0 | --- | --- | --- |
| Brussels Sprouts) | | | | | | | | | | | | | | | | | | | | | | |
| Plums | 31.4 | | | | | 9.0 | | | | | 8.9 | .1 | | | 23.6 | | | .7 | 2.6 | 2.0 | --- | 21.8 |
| Peaches | 14.0 | | | | | 4.0 | | | | | 25.0 | 1.0 | | | 8.0 | | | 32.0 | 4.0 | 1.0 | --- | 11.0 |
| Berries | 15.0 | | | | | 20.0 | | | | | 15.0 | 10.0 | | | 15.0 | | | --- | 20.0 | --- | --- | --- |
| Apples | 7.9 | | | | | .6 | | | | | 6.6 | 28.3 | | | 28.3 | | | 6.6 | .5 | 3.6 | --- | 17.6 |
| Pears | 11.9 | | | | | 2.1 | | | | | 72.1 | .04 | | | 3.2 | | | .1 | 1.0 | .8 | --- | 8.8 |
| Avocadoes | 25.0 | | | | | 8.0 | | | | | 25.0 | | | | | | | | 9.0 | 4.0 | --- | 27.0 |

*This information developed by Ivan Garcia from INDECA sources for this market analysis

Table 5. Annual Tonnage, Farm Value and Percentage of National Production Identified with the Huehuetenango Market Area No. 1, 1975

| Crop | Area of Concentration | Metric Tons | Value | Percent of Total Production |
|---|---|---|---|---|
| Tomatoes | Dispersed | 425 | $ 31,910 | * |
| Onions | Dispersed | 750 | 112,360 | 4.5 |
| Potatoes | Huehuetenango | 5,078 | 660,114 | 20.0 |
| Carrots | Huehuetenango | 1,487 | 248,252 | 9.0 |
| Garlic | Huehuetenango | 3,696 | 1,644,826 | 70.0 |
| Chard | Huehuetenango | 24 | 7,050 | * |
| Plums | | 6 | 3,030 | * |
| Peaches | | 11 | 2,160 | 1.0 |
| Berries | | 12 | 2,700 | 10.0 |
| Apples | | 860 | 344,000 | 28.3 |
| Pears | | 5 | 5,600 | * |
| Total | | 12,363 | $3,061,968 | |

*Less than 1 percent of total production.

Table 6. Annual Tonnage, Farm Value and Percentage of National Production Identified with the San Marcos, Quezaltenango, Totonicapan Market Area No. 2 , 1975

| Crop | Area of Concentration | Metric Tons | Value | Percent of Total Production |
|---|---|---|---|---|
| Tomatoes | Dispersed | 85 | $ 6,381 | * |
| Onions | Almolonga, Zunil | 3,991 | 599,256 | 24 |
| Cabbage | San Marcos, Almolonga, Zunil | 11,229 | 934,991 | 48 |
| Potatoes | San Marcos, Almolonga, Zunil | 10,394 | 1,386,239 | 42 |
| Carrots | San Marcos, Almolonga, Zunil | 5,238 | 910,257 | 33 |
| Garlic | Dispersed and Zunil | 264 | 117,487 | 5 |
| Beets | Almolonga, San Marcos, Zunil | 1,418 | 322,040 | 25 |
| Radishes | Almolonga, Zunil | 622 | 208,763 | 13 |
| Celery | Almolonga, Zunil | 285 | 95,220 | 34 |
| Chard | Almolonga, Zunil | 3,607 | 1,082,532 | 40 |
| Green Beans | San Marcos, Almolonga, Zunil | 1,036 | 75,110 | 20 |
| Cauliflower | San Marcos, Almolonga, Zunil | 5,600 | 895,776 | 40 |
| Lettuce | Almolonga, Zunil | 1,605 | 291,600 | 30 |
| Spinach | Almolonga, Zunil | 454 | 104,190 | 30 |
| Peas | San Marcos, Almolonga, Zunil | 467 | 109,557 | 20 |
| Asparagus | | | | |
| Broccoli | Almolonga, Zunil | 18 | 9,015 | 20 |
| Brussels Sprouts | | | | |
| Plums | | 231 | 79,689 | 26 |
| Peaches | | 443 | 88,560 | 41 |
| Berries | | 18 | 4,050 | 15 |
| Apples | | 1,440 | 318,000 | 64 |
| Pears | | 32 | 7,140 | 5 |
| Avocadoes | | 1,000 | 166,650 | 5 |
| Total | | 49,477 | $ 7,813,103 | |

*Less than 1 percent of total production.

Table 7. Annual Tonnage, Value and Percentage of National Production Identified with the Tecpan, Solola and Quiche Market Area No. 3, 1975

| Crop | Area of Concentration | Metric Tons | Value | Percent of Total Production |
|---|---|---|---|---|
| Tomatoes | Dispersed | 1,702 | $ 127,638 | 2 |
| Onions | Tecpan, Comalapa, Solola | 1,497 | 224,721 | 9 |
| Cabbage | Tecpan, Comalapa, Solola | 6,550 | 554,441 | 28 |
| Potatoes | Tecpan, Comalapa, Solola | 3,301 | 990,171 | 13 |
| Carrots | Tecpan, Comalapa, Solola | 6,032 | 1,048,175 | 38 |
| Garlic | Tecpan, Comalapa, Solola | 791 | 352,463 | 15 |
| Beets | Tecpan, Comalapa, Solola | 2,268 | 515,263 | 40 |
| Radishes | Tecpan, Comalapa, Solola | 1,149 | 385,410 | 24 |
| Turnips | Tecpan, Comalapa, Solola | 970 | 213,546 | 55 |
| Celery | Tecpan, Comalapa | 276 | 92,420 | 33 |
| Chard | Tecpan, Comalapa | 1,803 | 514,266 | 20 |
| Green Beans | Tecpan, Comalapa, Solola | 2,073 | 150,550 | 40 |
| Cauliflower | Tecpan, Comalapa | 4,200 | 671,832 | 30 |
| Lettuce | Tecpan, Comalapa | 535 | 97,200 | 10 |
| Spinach | Solola, Tecpan, Comalapa | 605 | 138,920 | 40 |
| Peas | Tecpan, Comalapa | 817 | 191,724 | 35 |
| Asparagus | | | | |
| Broccoli | Solola, Tecpan, Comalapa | 35 | 4,429 | 40 |
| Brussels Sprouts | | | | |
| Plum | | 80 | 26,058 | 9 |
| Peaches | | 76 | 15,120 | 7 |
| Berries | | 33 | 7,560 | 28 |
| Apples | | 45 | 12,000 | 2 |
| Pears | | 19 | 4,000 | 3 |
| Avocadoes | | 3,000 | 499,950 | 15 |
| Total | | 35,809 | $ 6,830,457 | |

Table 3. Annual Tonnage, Value, and Percentage of National Production Identified with the Guatemala Market Area No. 4 , 1975

| Crop | Area of Concentration | Metric Tons | Value | Percent of Total Production |
|---|---|---|---|---|
| Tomatoes | Dispersed | 11,911 | $ 893,466 | 14 |
| Onions | Sacatepequez, Dispersed | 2,328 | 349,566 | 14 |
| Cabbage | Sacatepequez, Dispersed | 5,614 | 467,496 | 24 |
| Potatoes | Dispersed | 3,301 | 429,074 | 13 |
| Carrots | Sacatepequez, Dispersed | 3,174 | 551,167 | 20 |
| Garlic | Dispersed | 528 | 234,975 | 10 |
| Beets | Sacatepequez, Dispersed | 1,985 | 450,856 | 35 |
| Radishes | Sacatepequez, Dispersed | 1,915 | 642,350 | 40 |
| Turnips | Sacatepequez, Dispersed | 794 | 174,179 | 45 |
| Celery | Sacatepequez | 276 | 92,420 | 33 |
| Chard | Sacatepequez | 3,607 | 1,082,532 | 40 |
| Cucumbers | Dispersed | 825 | 167,534 | 15 |
| Green Beans | Sacatepequez, Dispersed | 2,074 | 150,220 | 40 |
| Cauliflower | Sacatepequez | 4,200 | 671,832 | 30 |
| Lettuce | Sacatepequez, Dispersed | 3,210 | 583,200 | 60 |
| Spinach | Sacatepequez | 454 | 104,300 | 30 |
| Peas | Sacatepequez, Dispersed | 1,050 | 246,503 | 45 |
| Asparagus | | | | |
| Broccoli | Sacatepequez, Dispersed | 35 | 18,029 | 40 |
| Brussels Sprouts | | | | |
| Plums | | 390 | 133,017 | 44 |
| Peaches | | 432 | 86,400 | 40 |
| Berries | | 55 | 12,690 | 47 |
| Apples | | 293 | 66,000 | 13 |
| Pears | | 529 | 117,800 | 84 |
| Avocadoes | | 10,598 | 1,766,490 | 53 |
| Total | | 59,578 | $ 9,493,386 | |

Summaries of production value of crops and the number of small farmers in each of these areas follows:

HUEHUETENANGO MARKET AREA NO. 1

30,000 small farmers 3/

Farm value of fruits and vegetables = $3,061,968

High volume crops:

Garlic - - - - - 3,696 M.T.

Potatoes - - - - 5,078 M.T.

Carrots - - - - 1,487 M.T.

Apples - - - - - 860 M.T.

SAN MARCOS, QUEZALTENANGO, TOTONICAPAN MARKET AREA NO. 2

51,000 small farmers 4/

Farm value of fruits and vegetables = $6,838,824

High volume crops:

Onions - - - - - 3,991 M.T.

Cabbage - - - 11,229 M.T.

Potatoes - - - 10,394 M.T.

Carrots - - - - 5,238 M.T.

Beets - - - - - 1,418 M.T.

Chard - - - - - 3,607 M.T.

Cauliflower - - 5,600 M.T.

Apples - - - - - 1,440 M.T.

---

3/ & 4/ Farm 5 hectares or less.

TECPAN, SOLOLA, QUICHE MARKET AREA NO. 3

30,000 small farmers 5/

Farm value of fruits and vegetables = $6,830,457

High volume crops:

Onions - - - - - 1,497 M.T.

Cabbage - - - - 6,550 M.T.

Potatoes - - - - 3,301 M.T.

Carrots - - - - 6,032 M.T.

Garlic - - - - - - 791 M.T.

Beets - - - - - 2,268 M.T.

Radishes - - - - 1,149 M.T.

Turnips - - - - - 970 M.T.

Chard - - - - - 1,803 M.T.

Cauliflower - - 4,200 M.T.

Avocado - - - - 3,000 M.T.

GUATEMALA MARKET AREA NO. 4 (including Sacatepequez)

25,000 small farmers 6/

Farm value of fruits and vegetables = $9,493,386

High volume crops:

Tomatoes - - - 11,911 M.T.

Onions - - - - - 2,328 M.T.

Cabbage - - - - 5,614 M.T.

Beets - - - - - 1,985 M.T.

Radishes - - - - 1,915 M.T.

Chard - - - - - 3,607 M.T.

---

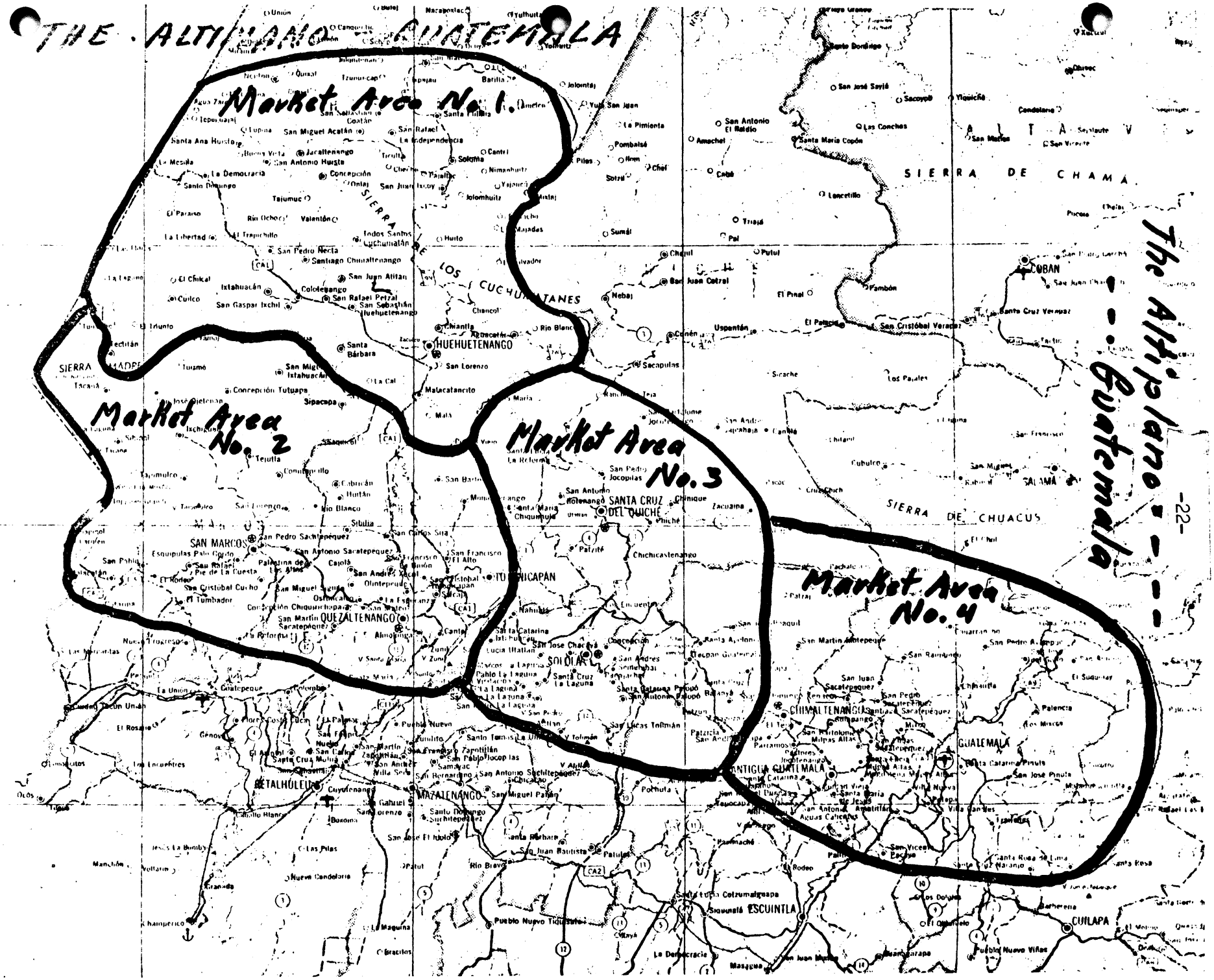
5/ & 6/ Farm 4 hectares or less.

Cauliflower - - 4,200 M.T.

Lettuce - - - - 3,210 M.T.

Avocados - - - 10,598 M.T.

The map of the highlands area outlines the above market areas. The boundaries of the market areas are shaped by natural barriers such as mountains and rivers, by location of roads, by location of production areas, by location of centers of population and by nearby market areas.


THE ALTIPLANO GUATEMALA
Market Area No. 1.
Market Area No. 2
Market Area No. 3
Market Area No. 4
The Altiplano - Guatemala
-22-
SIERRA DE LOS CUCHUMATANES
SIERRA MADRE
SIERRA DE CHAMA
SIERRA DE CHUACUS
ALTA VERAPAZ
HUEHUETENANGO
SAN MARCOS
QUEZALTENANGO
TOTONICAPAN
SOLOLA
SANTA CRUZ DEL QUICHE
CHIMALTENANGO
ESCUINTLA
RETALHULEU
MAZATENANGO
CUILAPA
COBAN

## PHYSICAL FACILITIES

### Buildings, Offices, Equipment and Refrigeration

The proposed physical facilities are designed for the volume of crops to be handled at the end of the fifth year of operation. The building for the Huehuetenango area would be the smallest, but would still provide room for considerable holding (short-term storage) of garlic, potatoes and onions grown in that area. (See appendix for storage information.) Refrigeration is included to develop information about storage of apples in preperation for a seasonal or intermediate term apple storage program in future years. Information is needed about varieties that store well, how long the storage period can be while maintaining quality, to check various stages of maturity when various apple varieties should be put into storage, and a record of daily and weekly price changes over time.

The Quezaltenango area and the Tecpan-Solola facilities are identical in size, but with some difference in grading belts and conveyors because of differences in volumes of crops produced in these areas. In both cases, however, the facilities provide room for short-term holding actions when prices are temporarily depressed. The refrigerated space in these two facilities would be used to accumulate quantities of the very perishable products and provide space for a limited holding action of a few days to bridge short-term fluctuations in the market.

The Guatemala facility is the largest. This facility would serve a dual role. First, the Guatemala location would, like the other areas, receive crops from farmers at the area. Second, it must also receive shipments from the other regions in order to provide at the terminal location a quantity and selection that will satisfy buyers for both the domestic and export market. Because of this dual role, more refrigeration space is provided and the building itself is about 35% larger than any other regional center.

A schematic market floor plan is presented in figure 1, which identifies suggested size and layout features for the market facilities.

Equipment for Markets

Because of the number of crops to be handled and because of low labor costs, specialized mechanized packing lines are not considered feasible. Two basic grading tables are suggested. One, a roller conveyor, would be used to sort, size and grade crops such as potatoes, onions and garlic. Most other crops would pass over a belt where handpackers would pick and pack into suitable cartons, bags or nets, as market demand and maintenance of product quality dictate.

Platform scales between every other receiving overhead door would provide for weighing in crops received in mixed loads or in small lots. Scales would be provided at about every other hand packing station to check weights of cartons, bags or nets prior to moving to holding area or to outgoing trucks.

Hand clamp trucks and hand carts would be provided to move the packed product from the packing line to the holding area or outgoing truck. The use of pallets and pallet handling equipment is not provided for initially because neither the incoming loads nor destination of the packed product permit such handling. Should mechanization of handling prove feasible in the future, this equipment can easily be added.

Equipment for each area is suggested below:

Huehuetenango:

1 - dump ledge with 24" x 20' roller table

1 - dump ledge with 30" x 20' grading belt

3 - hand clamp trucks

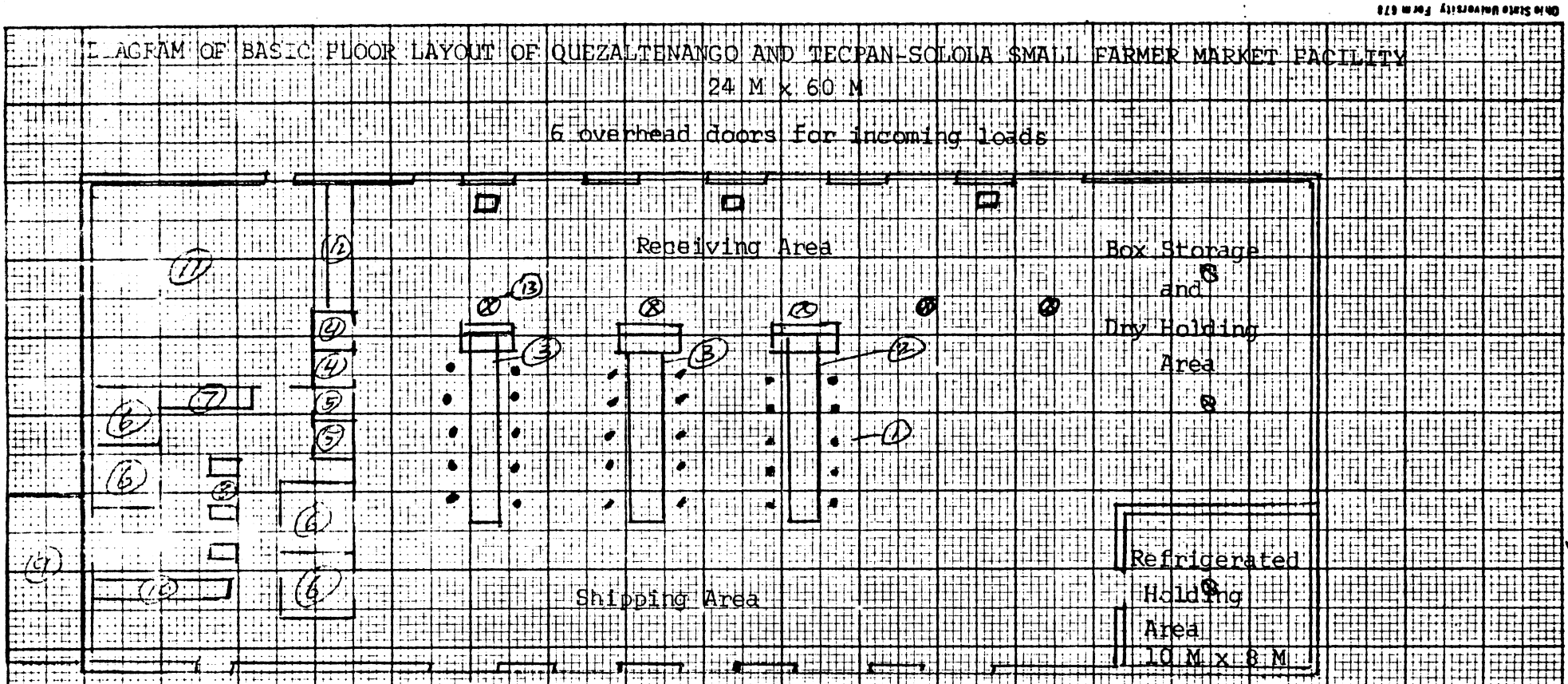
3 - hand trucks

1 - platform scales at receiving doors

6 - scales for weighing cartons, bags, nets at packing stations

DIAGRAM OF BASIC FLOOR LAYOUT OF QUEZALTENANGO AND TECPAN-SOLOLA SMALL FARMER MARKET FACILITY

24 M x 60 M




Code:

1. Packing stations
2. Dumping ledge & roller conveyer
3. Dumping ledge & belt
4. Packing Floor Toilets
5. Office Toilets
6. Offices
7. Files
8. Secretaries desks
9. Truck scales
10. Reception counter
11. Meeting room
12. Food preparation equipment
13. Floor Drain

Note - - - Building for Guatemala would have 3 coolers of equal size located accross end of building. The Guatemala building would be 21 M longer to accomodate additional coolers and incoming shipments from associated regional centers. The Guatemala building would be 24M x 81M. The office area would remain the same. The general managers office and staff would be located adjacent or nearby in 14 M x 18 M space. The Huehuetenango market would be similar but with a smaller packing floor. The Huehuetenango market would measure 24 M x 42 M.

Figure 1.



/a...

Quezaltenango:

2 - dump ledge with 24" x 20' roller tables

1 - dump ledge with 30" x 20' grading belt

6 - hand clamp trucks (for moving cartoned pack)

8 - hand trucks

3 - platform scales at receiving doors

12 - scales for weighing at packing stations

Solola-Tecpan:

1 - dump ledge with 24" x 20' roller table

2 - dump ledge with 30" x 20' grading belt

6 - hand clamp trucks (for moving cartoned pack)

8 - hand trucks

3 - platform scales at receiving doors

12 - scales for weighing as at packing station

Guatemala:

2 - dump ledge with 24" x 20' roller tables

2 - dump ledge with 30" x 20' grading belt

8 - hand clamp trucks (for moving cartoned pack)

10 - hand trucks

4 - platform scales at receiving doors

16 - scales at packing stations

The conveyors and belts should be spaced to allow room to accumulate loads [illegible] in the packing area. Lighting should be provided over each [illegible] to allow efficient and accurate grading, packing and weighing. Over- [illegible] tions for water hoses should be provided at the head of each packing

line for washing dirty products. A floor drain should be located at each washing station.

Office and Other Services

Each market building would provide space for management and the support staff. This would include a service counter, secretary's desk, 4 offices, file space and a combination meeting room and eating space. The eating space would include sink, cooking facilities and refrigerator. Separate toilet facilities for the office and packing area would be provided.

Headquarters

Headquarters building for the general manager and his support staff should be located at the terminal. It could be adjacent to, but not part of, the Guatemala grading and packing plant. A suggested area of 250 $M^2$ should provide sufficient space for the future.

Projected Costs and Returns, 1975-1983

Two major influences will affect future monetary values of crops, market sales and market costs. The volume of production of many crops has increased substantially over the past decade. Projections indicate that production of the crops under consideration will increase at a rate of 2.1% per year through 1983. (See appendix for graph of this production trend.)

Inflation is the second major force affecting total dollar value of crops, sales, and costs. This has been projected at the rate of 6% per year.

The accumulation of these two influences on sales and costs are shown in Table 9. This increase in production and inflation has been included when estimating costs and returns of the proposed market plan over the initial five-year period of market operation.

TABLE 9

PROJECTIONS OF CHANGE IN VALUE DUE TO PRODUCTION INCREASES AND INFLATION OVER BASE YEAR 1975-76 = 100 FOR FRUITS & VEGETABLES IN HIGHLANDS OF GUATEMALA

| | Annual Rate | 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 |
|---|---|---|---|---|---|---|
| Increases in Production | 2.1% | 106.4 | 108.7 | 111.1 | 113.3 | 115.7 |
| Inflation | 6.0% | 119.1 | 126.2 | 133.8 | 141.9 | 150.4 |
| Total | | 126.7 | 137.2 | 148.5 | 160.7 | 174.1 |

Purchasing Crops from Farmers and Trucking to Regional Assembly Points and to Guatemala City

At every stage in the present marketing system for fruits and vegetables in Guatemala, cash is exchanged for the crop at the point of purchase. Those familiar with the system are firm in their conviction that anyone or any organization which attempts a major change quickly in the cash-product exchange system will not effectively compete with other buyers who continue to offer cash.

It is suggested that each regional marketing organization employ two or more buyers who will do the country buying. Initially, these buyers will need to exchange cash for product at the farm or in the local municipio market. This will create major problems for control purposes and the marketing organization will need to develop stringent, well understood and enforceable controls to prevent [illegible] which may be directed at both farmers and the available currency that buyers have to pay for product. Over a few years, these [illegible] as they gain

the trust of small farmers, should move to a form of delayed payment where the cash is dispersed from the regional offices. This could be encouraged immediately by suggesting the farmer ride the truck taking his crop to the regional assembly center. In the future, with a developed sense of trust, the buyer could present the farmer with a voucher which could be cashed at any time at the regional center.

Each buyer would be provided with a pick-up truck with scales, to contact local markets and farmers. The scales would provide accuracy for the organization, and would quickly influence the present system of "hit-and-miss" pricing, which leads to unrealistic values for the farmers' crops where weights are estimated.

In off seasons, or during slack days, these buyers should visit farmers agreeing to buy their crops, meet with farmer leaders in the farmers local municipio, and cultivate relationships with local cooperatives and their leaders, to encourage farmers to sell to this new marketing cooperative.

In addition, the marketing organization, with the assistance of their buyers, local cooperatives and other farm leadership, should encourage the development of local marketing committees who could observe buying operations and provide a source of mediation in cases of disputes between the buyer and a farmer. The development of these local committees is considered essential to the success of this marketing project.

It is contemplated that the marketing cooperative own no trucks for hauling crops or packed product. Trucks are apparently readily available at competitive rates. In addition, these truckers, if employed as needed by the cooperative, could become allies for this organization, rather than obstacles to successful operations, as they might be if they were displaced by a cooperatively owned hauling fleet. Also, the cooperatively operated trucks would have difficulty

in matching the present efficiency of privately owned trucks who apparently are able to arrange return loads for most of their trips.

TABLE 10

TRUCKING COSTS AS PROJECTED THROUGH 1982-83

FROM PRODUCTION AREAS TO GUATEMALA CITY

| AREA | Base Area 1976 | Cost per Metric Ton - 5-ton load 1978-79 | 1979-80 | 1980-81 | 1981-82 | 1982-83 |
|---|---|---|---|---|---|---|
| Sacatepéquez | $6.20 | $7.80 | $8.30 | $8.80 | $9.30 | $9.90 |
| Chimaltenango | 6.40 | 8.00 | 8.60 | 9.10 | 9.60 | 10.20 |
| Tecpán | 8.00 | 10.10 | 10.70 | 11.40 | 12.00 | 12.70 |
| Sololá | 10.40 | 13.10 | 13.90 | 14.80 | 15.60 | 16.50 |
| Totonicapán | 11.20 | 13.00 | 14.10 | 15.90 | 15.50 | 16.80 |
| Quezaltenango | | | | | | |
| Concepción Chi Zuñil Almolonga | 11.80 | 14.90 | 15.00 | 16.80 | 17.70 | 18.80 |
| San Marcos | 13.00 | 16.40 | 17.40 | 18.50 | 19.50 | 20.60 |
| Tejutla | 13.70 | 17.30 | 18.40 | 19.50 | 20.60 | 21.80 |
| Huehuetenango | | | | | | |
| Chiantla Aguacatán | 13.00 | 16.40 | 17.40 | 18.50 | 19.50 | 20.60 |
| Soloma Chiloo | 14.50 | 18.30 | 19.40 | 20.60 | 21.80 | 23.10 |

## MARKET SHARE OF NEW MARKETING ORGANIZATION

The marketing cooperative should concentrate first on the large volume crops. During the initial year of operation, the organization should select the least perishable crops which have a high volume of production. These crops are potatoes, carrots, cabbage, beets, onions, garlic, turnips, apples, and perhaps peaches. Over the initial five-year period, these crops, because of location and concentration of production, will provide a large share of the strength of the cooperative marketing program.

Over time, two forces will tend to broaden the variety of crops purchased and sold by the cooperative. First, farmers will demand that most fruit and vegetable crops be purchased by the cooperative. Second, buyers will request a more complete assortment of crops packed and sold.

The information in Table 11 indicates a "best judgment" of the percentage of the altiplano fruit and vegetable production that the cooperative may be able to buy over the first five years of operations of the marketing cooperative. This percentage of each crop purchased by the cooperative has been applied to estimate income and expenses at the cooperative for the first (1978-79), third (1980-81) and fifth (1982-83) years of operations.

TABLE 11

ESTIMATED MARKET SHARE FOR ALTIPLANO SMALL FARMER, FRUIT & VEGETABLE MARKETING COOPERATIVE AS A PERCENTAGE OF TOTAL ALTIPLANO PRODUCTION

| Crop | 1st Year 1978-79 | 2nd Year 1979-80 | 3rd Year 1980-81 | 4th Year 1981-82 | 5th Year 1982-83 |
|---|---|---|---|---|---|
| Potatoes | 15 | 17 | 20 | 23 | 27 |
| Carrots | 10 | 12 | 15 | 18 | 20 |
| Cabbage | 12 | 15 | 18 | 20 | 22 |
| Cauliflower | | 5 | 10 | 15 | 18 |
| Chard | | | 5 | 10 | 10 |
| Beets | 5 | 8 | 10 | 13 | 17 |
| Onions | 8 | 10 | 13 | 17 | 21 |
| Lettuce | | 5 | 7 | 10 | 14 |
| Garlic | 20 | 22 | 25 | 27 | 30 |
| Green Beans | | 5 | 7 | 9 | 12 |
| Radishes | | 5 | 10 | 15 | 15 |
| Tomatoes | | 4 | 7 | 10 | 14 |
| Peas | | | 4 | 8 | 12 |
| Cucumbers | | 5 | 7 | 10 | 14 |
| Turnips | 5 | 8 | 11 | 14 | 17 |
| Spinach | | 5 | 8 | 11 | 15 |
| Celery | | 5 | 8 | 12 | 14 |
| Brussel Sprouts | | 5 | 8 | 10 | 15 |
| Brocolli | | 5 | 8 | 10 | 15 |
| Asparagus | | | | 5 | 10 |
| Plums | | 5 | 9 | 12 | 15 |
| Peaches | 9 | 12 | 15 | 18 | 23 |
| Berries | | | 5 | 10 | 10 |
| Apples | 15 | 18 | 20 | 22 | 24 |
| Pears | | 4 | 8 | 10 | 12 |
| Avocados | | | 5 | 10 | 12 |

## FARM, WHOLESALE AND RETAIL CROP VALUES

From earlier information developed for this project, the price, margin and shrink (loss in weight and value) at each stage of the marketing system for all crops under consideration has been identified (see appendix for summary). A retail value for each crop has been calculated from this information. Also, a wholesale value covering those functions and activities at the new marketing organization has been calculated for each crop. The information in Table 12 shows the farm value of each crop as a percentage of retail. The wholesale value for estimating selling prices for the new cooperative is also shown.

These factors are then used with the earlier estimated market share of the cooperative, to arrive at a projected sales figure for the first, third and fifth year of operations. The base year (1975) farm value, retail value, wholesale value for each crop are shown in Table 13.

TABLE 12

ALTIPLANO FARM VALUE AND WHOLESALE VALUE AS A PERCENTAGE OF RETAIL VALUE FRUITS AND VEGETABLES, GUATEMALA, 1976

| Crop | Farm Value as a % of Retail | Wholesale Value as a % of Retail |
|---|---|---|
| Potatoes | 35 | 60 |
| Carrots | 54 | 58 |
| Cabbage | 27 | 43 |
| Cauliflower | 62 | 66 |
| Chard | 74 | 78 |
| Beets | 60 | 68 |
| Onions | 29 | 63 |
| Lettuce | 70 | 82 |
| Garlic | 26 | 43 |
| Green Beans | 69 | 83 |
| Radishes | 37 | 57 |
| Tomatoes | 36 | 55 |
| Peas | 40 | 66 |
| Cucumbers | 19 | 45 |
| Turnips | 52 | 68 |
| Spinach | 58 | 85 |
| Celery | 57 | 75 |
| Brussel Sprouts | 20 | 60 |
| Asparagus | 91 | 95 |
| Brocolli | 69 | 76 |
| Plums | 40 | 54 |
| Peaches | 37 | 52 |
| Berries | 44 | 64 |
| Apples | 48 | 60 |
| Pears | 51 | 68 |
| Avocados | 16 | 40 |

TABLE 13

ESTIMATED ALTIPLANO CROP VALUES, GUATEMALA, 1975

| Crop | Farm Value | Retail Value | Wholesale Value | Metric Tons |
|---|---|---|---|---|
| | | (quetzales) | | |
| Potatoes | 3,375,060 | 9,643,029 | 5,785,817 | 25,962 |
| Carrots | 2,580,150 | 4,778,055 | 2,771,272 | 15,450 |
| Cabbage | 2,256,853 | 8,358,715 | 3,594,247 | 27,450 |
| Cauliflower | 1,536,320 | 2,477,935 | 1,635,437 | 9,602 |
| Chard | 2,601,600 | 3,515,676 | 2,742,227 | 8,672 |
| Beets | 1,116,780 | 1,944,633 | 1,322,350 | 5,140 |
| Onions | 676,150 | 2,331,551 | 1,468,877 | 9,002 |
| Lettuce | 1,035,944 | 1,479,920 | 1,213,534 | 5,692 |
| Garlic | 2,142,675 | 8,241,057 | 3,543,654 | 4,815 |
| Green Beans | 1,264,500 | 1,832,608 | 1,521,064 | 5,058 |
| Radishes | 1,244,454 | 3,363,389 | 1,917,131 | 3,704 |
| Tomatoes | 1,078,515 | 2,995,875 | 1,647,731 | 14,381 |
| Peas | 519,115 | 1,297,787 | 856,539 | 2,209 |
| Cucumbers | 151,580 | 797,789 | 359,005 | 715 |
| Turnips | 264,194 | 505,065 | 345,484 | 1,587 |
| Spinach | 313,720 | 540,847 | 459,762 | 1,364 |
| Celery | 265,655 | 466,061 | 349,545 | 793 |
| Brussel Sprouts | 3,564 | 17,820 | 10,692 | 54 |
| Brocolli | 14,000 | 20,290 | 15,420 | 80 |
| Asparagus | 20,800 | 22,857 | 21,714 | 16 |
| Plums | 225,000 | 562,500 | 303,750 | 625 |
| Peaches | 520,000 | 1,733,333 | 901,333 | 1,300 |
| Avocados | 584,000 | 3,650,000 | 1,460,000 | 14,600 |
| Berries | 47,700 | 108,409 | 69,382 | 106 |
| Apples | 1,300,420 | 2,709,208 | 1,625,525 | 2,827 |
| Pears | 371,200 | 727,843 | 494,933 | 928 |
| Total | | | | 161,873 |

## GROSS SALES, SHRINK, & TRUCKING COSTS 1978-83

Using the base year (1975) information from Table 13 and applying the estimated market share for the crops to be marketed in the first year of operation, both the cooperative market sales and the farm price at those sales is calculated for each crop. Subtracting the farm price (cost of goods) from market sales gives the cooperative gross income for 1978-79. These individual crop results are totaled to get a value of crops handled for that market year. Since some weight and quality loss will occur during the assembly and marketing process, a shrink factor (4%) for these crops is subtracted. The final result is a gross income and sales estimate for the first year of operation, $4,577,021 in sales and $1,037,715 in gross income for the cooperative. This information is presented in Table 14.

Similar data is developed for the third (1980-81) and fifth (1982-83) years of operation. As more crops with highly perishable characteristics are added in the third and fifth year, the shrink factor is increased to more accurately reflect this loss. The results are shown in Tables 15 and 16.

The sales figure for 1980-81 is $6,998,601 and for 1982-83 is $11,591,327. The gross income figure for 1980-81 is $1,927,844 and for 1982-83 is $3,099,577. From these amounts all operating costs must be paid.

TABLE 14. ESTIMATED MARKETING COSTS AND INCOMES, GUATEMALA, ALTIPLANO MARKETING COOPERATIVE 1978-79

| CROP | FARM VALUE | RETAIL VALUE | WHOLESALE VALUE | COOP MARKET SHARE MT | % | COOP MARKET SALES | COST OF GOODS OF COOP SALE | COOP GROSS INCOME | COOP TRUCKING COSTS |
|---|---|---|---|---|---|---|---|---|---|
| POTATOES | 4,286,326 | 12,246,029 | 7,347,617 | 4130 | 15 | 1,102,142 | 642,949 | 459,194 | 61,950 |
| CARROTS | 3,276,790 | 6,068,129 | 3,519,515 | 1638 | 10 | 351,952 | 327,690 | 24,262 | 21,294 |
| CABBAGE | 2,866,203 | 10,615,568 | 4,564,693 | 3459 | 12 | 547,763 | 343,944 | 203,819 | 51,885 |
| CAULIFLOWER | | | | | | | | | |
| CHARD | | | | | | | | | |
| BEETS | 1,481,810 | 2,469,603 | 1,679,384 | 272 | 5 | 83,969 | 74,090 | 9,849 | 4,080 |
| ONIONS | 858,711 | 2,961,070 | 1,865,473 | 763 | 8 | 149,237 | 68,697 | 80,540 | 9,919 |
| LETTUCE | | | | | | | | | |
| GARLIC | 2,721,197 | 16,241,057 | 4,500,440 | 1021 | 20 | 900,088 | 544,239 | 355,849 | 16,336 |
| GREEN BEANS | | | | | | | | | |
| RADISHES | | | | | | | | | |
| TOMATOES | | | | | | | | | |
| PEAS | | | | | | | | | |
| CUCUMBERS | | | | | | | | | |
| TURNIPS | 335,194 | 645,242 | 438,764 | 84 | 5 | 21,938 | 16,759 | 5,179 | 840 |
| SPINACH | | | | | | | | | |
| CELERY | | | | | | | | | |
| BR.SPROUTS | | | | | | | | | |
| BROCOLLI | | | | | | | | | |
| ASPARAGUS | | | | | | | | | |
| PLUMS | | | | | | | | | |
| PEACHES | 660,400 | 2,201,133 | 1,144,469 | 124 | 9 | 103,022 | 59,436 | 43,586 | 1,860 |
| PEACHES | | | | | | | | | |
| BERRIES | | | | | | | | | |
| APPLES | 1,651,533 | 3,440,694 | 2,064,417 | 450 | 15 | 309,663 | 247,730 | 61,933 | 6,750 |
| PEARS | | | | | | | | | |
| AVOCADOS | | | | | | | | | |
| TOTAL VALUE | | | | 11148 | 6.7 | 4,767,730 | | 1,244,424 | 174,875 |
| Less 4% Shrink | | | | | | (190,709) | | (190,709) | |
| Gross Sales & Income | | | | | | 4,577,021 | | 1,037,715 | |
| Trucking Costs | | | | | | | | (174,875) | |
| Coop Gross Income Less Trucking Costs | | | | | | | | 862,840 | |

TABLE 15. ESTIMATED MARKETING COSTS AND INCOMES, GUATEMALA, ALTIPLANO MARKETING COOPERATIVE 1980-81

| CROP | FARM VALUE | RETAIL VALUE | WHOLESALE VALUE | COOP MARKET SHARE MT | COOP MARKET SHARE % | COOP MARKET SALES | COST OF GOODS OF COOP SALE | COOP GROSS INCOME | COOP TRUCKING COSTS |
|---|---|---|---|---|---|---|---|---|---|
| POTATOES | 5,028,839 | 14,368,113 | 8,620,867 | 5764 | 20 | 1,724,173 | 1,005,768 | 718,405 | 96,835 |
| CARROTS | 3,844,424 | 7,119,302 | 4,129,195 | 2522 | 15 | 619,379 | 576,664 | 42,715 | 38,066 |
| CABBAGE | 3,511,711 | 12,454,485 | 5,355,428 | 5433 | 18 | 963,977 | 632,108 | 331,869 | 91,274 |
| CAULIFLOWER | 2,289,117 | 3,692,123 | 2,436,801 | 1066 | 10 | 243,680 | 228,912 | 14,768 | 9,381 |
| CHARD | 3,876,384 | 5,238,357 | 4,085,918 | 481 | 5 | 204,296 | 193,819 | 10,477 | 4,233 |
| BEETS | 1,738,502 | 2,897,503 | 1,970,302 | 571 | 10 | 197,030 | 173,850 | 23,180 | 8,451 |
| ONIONS | 1,007,464 | 3,474,011 | 2,188,627 | 1299 | 13 | 284,522 | 130,970 | 153,552 | 19,225 |
| LETTUCE | 1,543,557 | 2,205,081 | 1,808,166 | 442 | 7 | 126,572 | 108,049 | 18,523 | 5,039 |
| GARLIC | 3,192,586 | 12,279,175 | 5,280,044 | 1336 | 25 | 1,320,011 | 798,146 | 521,865 | 24,716 |
| GREEN BEANS | 1,884,105 | 2,730,586 | 2,266,385 | 393 | 7 | 158,647 | 131,887 | 21,760 | 4,480 |
| RADISHES | 1,854,236 | 5,011,450 | 2,856,525 | 411 | 10 | 285,652 | 185,424 | 100,228 | 4,685 |
| TOMATOES | 1,606,987 | 4,463,854 | 2,455,119 | 1117 | 7 | 171,858 | 112,489 | 59,369 | 11,393 |
| PEAS | 773,481 | 1,933,697 | 1,276,392 | 98 | 4 | 51,056 | 30,939 | 20,117 | 1,117 |
| CUCUMBERS | 225,854 | 1,188,706 | 534,917 | 56 | 7 | 37,444 | 15,810 | 21,634 | 571 |
| TURNIPS | 393,649 | 752,547 | 514,771 | 194 | 11 | 56,625 | 43,301 | 13,324 | 2,212 |
| SPINACH | 467,443 | 805,937 | 685,045 | 121 | 8 | 54,804 | 37,395 | 17,409 | 1,258 |
| CELERY | 395,826 | 694,431 | 520,822 | 70 | 8 | 41,666 | 31,666 | 10,000 | 798 |
| BR.SPROUTS | 5,310 | 26,931 | 15,931 | 5 | 8 | 1,274 | 425 | 849 | 57 |
| BROCOLLI | 20,850 | 30,232 | 22,976 | 7 | 8 | 1,838 | 1,669 | 169 | 80 |
| ASPARAGUS | | | | | | | | | |
| PLUMS | 335,250 | 838,125 | 452,588 | 62 | 9 | 40,733 | 30,172 | 10,561 | 1,042 |
| PEACHES | 774,800 | 2,582,666 | 1,342,986 | 216 | 15 | 201,448 | 116,220 | 85,228 | 3,629 |
| PEACHES | | | | | | | | | |
| BERRIES | 71,073 | 161,529 | 103,379 | 6 | 5 | 5,169 | 3,554 | 1,615 | 68 |
| APPLES | 1,937,626 | 4,036,720 | 2,422,032 | 628 | 20 | 484,405 | 387,525 | 96,881 | 10,550 |
| PEARS | 553,088 | 1,084,486 | 737,450 | 82 | 8 | 58,996 | 44,247 | 14,749 | 722 |
| AVOCADOS | 870,160 | 5,438,500 | 2,175,400 | 810 | 5 | 108,770 | 43,508 | 65,262 | 7,371 |
| Total Value | 38,233,324 | 95,542,225 | 54,290,420 | 23,240 | 12.9 | 7,445,320 | 5,065,757 | 2,374,563 | 347,253 |
| Less 6% Shrink | | | | | | (446,719) | | (446,719) | |
| Coop Sales and Gross Income<br>Trucking Costs | | | | | | 6,998,601 | | 1,927,844<br>(347,253) | |
| Coop Gross Income less Trucking Costs | | | | | | | | 1,580,591 | |

TABLE 16. ESTIMATED MARKETING COSTS AND INCOMES, GUATEMALA, ALTIPLANO MARKETING COOPERATIVE 1982-83

| CROP | FARM VALUE | RETAIL VALUE | WHOLESALE VALUE | COOP MARKET MT | COOP MARKET SHARE % | COOP MARKET SALES | COST OF GOODS OF COOP SALE | COOP GROSS INCOME | COOP TRUCKING COSTS |
|---|---|---|---|---|---|---|---|---|---|
| POTATOES | 5,872,604 | 16,778,870 | 10,067,322 | 8271 | 27 | 2,718,177 | 1,585,603 | 1,132,574 | 155,495 |
| CARROTS | 4,489,461 | 8,313,816 | 4,822,013 | 3646 | 20 | 964,403 | 897,892 | 66,511 | 60,159 |
| CABBAGE | 3,926,924 | 14,544,164 | 6,253,990 | 7059 | 22 | 1,375,878 | 863,923 | 511,955 | 132,709 |
| CAULIFLOWER | 2,673,197 | 4,311,607 | 2,845,660 | 2039 | 18 | 512,219 | 481,175 | 31,044 | 20,186 |
| CHARD | 4,526,784 | 6,117,276 | 4,771,475 | 1023 | 10 | 477,148 | 452,678 | 24,470 | 10,128 |
| BEETS | 2,030,197 | 3,383,661 | 2,300,889 | 1031 | 17 | 345,133 | 345,133 | 46,018 | 17,012 |
| ONIONS | 1,176,501 | 4,056,899 | 2,555,846 | 2230 | 21 | 536,728 | 247,065 | 289,665 | 36,795 |
| LETTUCE | 1,802,543 | 2,575,061 | 2,111,549 | 940 | 14 | 295,617 | 252,356 | 43,261 | 11,938 |
| GARLIC | 3,728,254 | 14,339,439 | 6,165,958 | 1704 | 30 | 1,849,787 | 1,118,476 | 731,311 | 35,102 |
| GREEN BEANS | 2,200,230 | 3,188,842 | 2,646,651 | 716 | 12 | 317,598 | 264,029 | 53,570 | 9,093 |
| RADISHES | 2,165,350 | 5,852,297 | 3,335,808 | 656 | 15 | 500,371 | 324,802 | 175,569 | 8,331 |
| TOMATOES | 1,876,616 | 5,212,822 | 2,867,052 | 2375 | 14 | 401,387 | 262,726 | 138,661 | 30,163 |
| PEAS | 903,260 | 2,258,149 | 1,490,552 | 313 | 12 | 178,866 | 108,391 | 70,475 | 3,975 |
| CUCUMBERS | 263,749 | 1,388,152 | 624,669 | 118 | 14 | 87,454 | 36,925 | 50,529 | 1,203 |
| TURNIPS | 459,698 | 878,813 | 601,142 | 318 | 17 | 102,194 | 78,149 | 24,045 | 4,039 |
| SPINACH | 545,873 | 941,074 | 799,986 | 241 | 15 | 119,998 | 81,881 | 38,117 | 3,060 |
| CELERY | 462,240 | 810,946 | 608,208 | 131 | 14 | 85,149 | 64,714 | 20,435 | 1,663 |
| BR.SPROUTS | 6,201 | 31,007 | 18,604 | 8 | 15 | 2,791 | 930 | 1,861 | 102 |
| BROCOLLI | 24,360 | 35,305 | 26,831 | 14 | 15 | 4,025 | 3,654 | 371 | 178 |
| ASPARAGUS | 36,192 | 39,771 | 37,782 | 2 | 10 | 3,778 | 3,619 | 159 | 25 |
| PLUMS | 391,500 | 978,750 | 528,525 | 110 | 15 | 79,279 | 58,725 | 20,554 | 2,068 |
| PEACHES | 904,800 | 3,015,999 | 1,568,319 | 353 | 23 | 350,713 | 208,104 | 152,609 | 6,636 |
| PEACHES | | | | | | | | | |
| BERRIES | 82,998 | 188,632 | 120,725 | 13 | 10 | 12,072 | 8,300 | 3,772 | 165 |
| APPLES | 2,262,731 | 4,714,022 | 2,828,414 | 801 | 24 | 678,819 | 543,055 | 135,764 | 15,059 |
| PEARS | 645,888 | 1,266,447 | 861,183 | 131 | 12 | 103,342 | 77,507 | 25,835 | 1,297 |
| AVOCADOS | 1,016,160 | 6,351,000 | 2,540,400 | 2067 | 12 | 304,848 | 121,939 | 182,909 | 20,463 |
| Total Value | | | | 36,310 | 19.4 | 12,463,792 | | 3,972,042 | 587,044 |
| Less 7% Shrink | | | | | | (872,465) | | (872,465) | |
| | | | | | | 11,591,327 | | 3,099,577 | |
| Trucking Costs | | | | | | | | 587,533 | |
| Coop Gross Income less Trucking Costs | | | | | | | | 2,612,533 | |

## CAPITAL BUDGET

Capital budget requirements total $1,385,200. The amounts for land reflect estimates of what land will cost at the time of purchase. It is recognized that it will be difficult to acquire the suggested amount of land in or on the perimeter of the terminal market for the market building. Likely alternatives are to lease or renovate an older building. In this case, we would have an expense item as rent rather than one of capital costs represented by interest costs on land and buildings. It is absolutely essential that the headquarters offices be located in or adjacent to the Guatemala terminal market. The market building itself could be located elsewhere, although not desirably so. The amounts associated with the major classification at the capital budget are identified in Table 17.

The outlying regional markets should try to acquire about 1½ hectares of land where utilities (especially electricity) are available and land preparation costs are minimized. This amount of land would permit market expansion, allow future storage development and permit the long range possibility of some processing operations at that site. It is not considered necessary to select a site in the urban area.

As a start on site location, the Huehuetenango market should be located near or on the C.A.I. highway (The Pan American Highway), near Huehuetenango, to provide access to producing areas such as Aguacatan, Chiantla, San Juan Ixcoy, Soloma, and Quilco, all the while moving the products toward the terminal market.

Likewise, the market for Quezaltenango might well be located on the road from Quezaltenango to C.A.I. Most major production areas in this region, whether at Tejutla, Zunil, or Concepcion Chichi, are located so that the market would be between the production areas and the terminal market. This would tend to keep back hauls to a minimum.

The market location for Quiche, Solola, Tecpan market is less clear, although a location between Tecpan and Chimaltenango is preferred for transportation reasons.

More detailed site feasibility studies will be necessary, when the project is approved.

TABLE 17

CAPITAL BUDGET

Guatemala Small Farmer Fruit and Vegetable Marketing Project, 1976

| | | | Quetzales |
|---|---|---|---|
| Land | | | |
| | Guatemala Terminal Area | 100,000 | |
| | Tecpan - Solola Area 1½ H | 20,000 | |
| | Quezaltenango Area 1½ H | 40,000 | |
| | Huehuetenango Area 1½ H | 12,000 | |
| | | | 172,000 |
| Market Building | | | |
| | Guatemala 24 M x 81 M = | 1944 $M_2$ | |
| | Solola-Tecpan 24 M x 60 M = | 1440 $M_2$ | |
| | Quezaltenango 24 M x 60 M = | 1440 $M_2$ | |
| | Huehuetenango 24 M x 42 M = | 1008 $M_2$ | |
| | | 5832 $M_2$ | |
| | | at $140 $M_2$ | 817,000 |
| Headquarters | | | |
| | Guatemala - 14 M x 18 M = | 252 $M_2$ | |
| | | $100 $M_2$ | 25,200 |
| Refrigeration | | | |
| | 6 - 8 M x 10 M with equipment | | 106,000 |
| Equipment | | | |
| | Conveyors, scales, hand trucks, etc. | | 115,000 |
| Pick-up Trucks with Scales | | | |
| | 11 at $5,000 (for buyers) | | 55,000 |
| Office Equipment | | | |
| | Headquarters and 4 locations | | 70,000 |
| Radio Communications Equipment | | | |
| | 5 units | | 25,000 |
| TOTAL INVESTMENT | | | |
| | Land, Buildings and Equipment | | 1,385,200 |

## MANAGEMENT AND SUPPORT BUDGET

The management and support budget is divided into two major groups. The terminal group includes only the general manager and his team. Ability of this level of management is essential to the success of this project. (See Table 18)

The salary suggested for the general manager is one that should attract the best qualified fruit and vegetable marketing manager in Guatemala. It should be a person who has considerable organizational talent, one who has contacts in the marketing system, and one who has a finely tuned business sense. The two sales managers should also have many contacts in the terminal market and have demonstrated sales capabilities. These two individuals might well divide their sales efforts - one to sell crops like potatoes, onion, garlic, and the other to become a specialist for the more perishable crops.

The second group aggregates the management and support people for all four regional assembly centers. The ability and efforts of this total management group will be the key to whether this project is able to achieve the desired objectives.

The board of directors must give operational control to this group, headed by the general manager, and hold him responsible for the success or shortcomings that may develop over time. Similarly, when setting policy, the board itself must concentrate on building sales volume with a quality product, and subjugate all other influences that could affect the sales building effort. There are two groups which must be satisfied in order to reach full business potential. First, the farmer who wants an assured market at a just price; second, the buyer who wants an assured supply of a given quality that can be depended upon. Satisfying both groups is essential.

TABLE 18

MANAGEMENT SUPPORT BUDGET

Guatemala Small Farmer Fruit and Vegetable Marketing Project, 1976

| Management and Support | | Quetzales |
|---|---|---|
| Terminal | | |
| | General Manager | 24,000 |
| | Sales Managers (2) | 40,000 |
| | Operations Manager | 12,000 |
| | Office Manager | 9,000 |
| | Secretaries (4) at $4,000 | 16,000 |
| Regional Assembly - 4 locations | | |
| | Manager (4) | 28,000 |
| | Supervisor of operations (4) | 24,000 |
| | Accountant (4) | 20,000 |
| | Buyers (11) | 55,000 |
| | Secretaries (12) at $3,000 | 36,000 |
| Management and Support | | 264,000 |

## PROJECTED INCOME AND EXPENSE STATEMENTS

Sales, cost of goods, gross income and expense budgets are presented in Tables 19, 20, and 21. The first year's operation indicates a net loss of $123,000 or 2.7% of sales.

The third year of operation shows a savings of $65,000 or .9% of sales.

The fifth year of operations indicates a savings of $319,000, or 2.6% of sales. This is a return on capital at 23%, which is considered most satisfactory.

The sales breakeven point (where the cooperative will start to show a savings) is $6,400,000 per year. This point should be reached in the latter part of the third year. Accumulated losses at this point will be about $217,000 over the 1978-81 period.

Operating capital subsidies will be needed to cover start up costs, initial operating costs, and inventory costs. These needs are estimated at $500,000.

TABLE 19

INCOME STATEMENT 1978-79

Guatemala Small Farmer Fruit and Vegetable Marketing Project

| | Quetzales | Percent of Sales |
|---|---|---|
| Sales | 4,557,000 | 100.0 |
| Cost of Goods | 3,519,000 | 77.2 |
| Gross Income | 1,038,000 | 22.8 |
| Controllable Expenses | | |
| Wages | $110,000 | |
| Trucking | 175,000 | |
| Containers at $22 MT | 245,000 | |
| Supplies | 40,000 | |
| | $570,000 | 12.5 |
| Non-Controllable | | |
| Management and Support | $264,000 | |
| Depreciation Buildings | 42,000 | |
| Depreciation Equipment | 34,000 | |
| Taxes (including Soc. Sec.) | 48,000 | |
| Repairs and Maintenance | 23,000 | |
| Insurance | 20,000 | |
| Utilities | 15,000 | |
| Legal and Miscellaneous | 20,000 | |
| Interest (9%) | 125,000 | |
| | $591,000 | 12.9 |
| Total Expenses | $1,161,000 | 25.4 |
| Savings/Loss | $123,000 | 2.7 |

TABLE 20

INCOME STATEMENT 1980-81

Guatemala Small Farmer Fruit and Vegetable Marketing Project

| | Quetzales | Percent of Sales |
|---|---|---|
| Sales | 6,999,000 | 100.0 |
| Cost of Goods | 5,071,000 | 72.5 |
| Gross Income | 1,928,000 | 27.5 |
| Controllable | | |
| Wages | $230,000 | |
| Trucking | 347,000 | |
| Containers | 581,000 | |
| Supplies | 58,000 | |
| | $1,216,000 | 17.4 |
| Non-Controllable | | |
| Management and Support | $295,000 | |
| Depreciation Buildings | 42,000 | |
| Depreciation Equipment | 34,000 | |
| Taxes (including Soc. Sec.) | 68,000 | |
| Repairs and Maintenance | 23,000 | |
| Insurance | 22,000 | |
| Utilities | 18,000 | |
| Legal and Miscellaneous | 20,000 | |
| Interest | 125,000 | |
| | $647,000 | 9.2 |
| Total Expenses | $1,863,000 | 26.6 |
| Savings/Loss | $65,000 | .9 |

TABLE 21

INCOME STATEMENT 1982-83

Guatemala Small Farmer Fruit and Vegetable Marketing Project

| | Quetzales | Percent of Sales |
|---|---|---|
| Sales | 12,464,000 | 100.0 |
| Cost of Goods | 9,364,000 | 75.1 |
| Gross Income | 3,100,000 | 24.9 |
| Controllable Expenses | | |
| Wages | $363,000 | |
| Trucking | 588,000 | |
| Containers | 1,017,000 | |
| Supplies | 100,000 | |
| | $2,068,000 | 16.6 |
| Non-Controllable Expenses | | |
| Management and Support | 225,000 | |
| Depreciation Buildings | 42,000 | |
| Depreciation Equipment | 34,000 | |
| Taxes (including Soc. Sec.) | 89,000 | |
| Repairs and Maintenance | 23,000 | |
| Insurance | 25,000 | |
| Utilities | 30,000 | |
| Legal and Miscellaneous | 20,000 | |
| Interest | 125,000 | |
| | $713,000 | 5.7 |
| Total Expenses | $2,781,000 | 22.3 |
| Savings/Loss | $319,000 | 2.6 |

## FOR THE FUTURE - STORAGE

There is much interest among present cooperative Federation management, in local cooperatives and among farmers about storing crops in order to achieve a better price. Storage of crops, although simple in appearance, is complex and technical in nature, specific to each commodity, and carries a substantial financial risk. Storage programs should not be entered into lightly.

Storage, as used here, supposes a longer period of time than a few days that is envisioned for the marketing facilities and program described for the 1978-83 period. Storage, as used here, involves a time period of several weeks to several months.

In addition to technical risks, which may result in loss in quality or loss of the crop, there are substantial economic risks. Relatively few crops in Guatemala during the 1973-76 period had price changes at a regular and cyclical nature which could result in lessening the price risk of holding crops in storage. To reinforce this point, every storage program tried in Guatemala by farm groups in recent years has resulted in a loss of money for the program. These losses reflected both the technical aspects of storage and the price risks involved.

Only five vegetables and one fruit crop in the Guatemalan Highlands during the period 1973-76 had price cycles of some regularity which would make storage programs less risky, less speculative. A marketing organization cannot and must not expose their organization and their members to storage programs where there is a high degree of risk associated with price change.

The five vegetables whose price changes had some predictable cyclical activity were carrots, beets, potatoes, onions and garlic. All of these cycles are months long. The typical low periods and high periods in price are identified on the next page.

| Crop | Low Price Period Crop into Storage | High Price Period Product out of Storage |
|---|---|---|
| Carrots | Oct., Nov., Dec. | March, April, May |
| Beets | Sept., Oct., Nov. | April, May, June |
| Potatoes | July, Aug., Sept. | Feb., March, April |
| Onions | April, May | Sept., Oct. |
| Garlic | Feb., March | October |
| Apples | Sept., Oct. | Dec., Jan. |

Because of long time periods involved and uncertain payoffs, only the onion, potato, garlic and apple crops appear to be candidates for storage for more than a few days by a marketing organization at this time. Short term, limited holdings may, over time, provide some valuable experience which would be useful in considering storage, related payoffs and the risks associated with these payoffs.

One of the functions of the new marketing cooperative should be to accumulate daily price and quantity information for the fruit and vegetable crops under consideration. This kind of historical information useful in storage decisions is not available today. As this information accumulates, decisions about storage can be more rational.

It is proposed that storage plans, programs and facilities be activated as soon as the marketing cooperative is fully operational. In 1980-81, the marketing cooperative should be approaching a break even point financially. At this time, storage programs should be activated.

The location and specialty of storage facilities is suggested below:

Potato Storage

| | |
|---|---|
| 1 in Tejutla | 1200 M.T. |
| 1 in Quezaltenango | 900 M.T. |

Garlic Storage

| | |
|---|---|
| 1 in Huehuetenango | 600 M.T. |

Onion Storage

| | |
|---|---|
| 1 in Solola | 600 M.T. |
| 1 in Quezaltenango | 600 M.T. |

Apple Storage

| | |
|---|---|
| 1 in Saloma/San Juan Ixcoy | 200 M.T. |
| 1 in Quezaltenango | 200 M.T. |

The subject of storage, cropts stored, size and location of storage should be the subject of further consultation with experts on storing each of these commodities.

Where garlic, potato and onion storage are expected soon to be used for only a few weeks, unrefrigerated storage located in the higher elevations (above 8000') may well be satisfactory. If storage periods are contemplated, which may be longer than 3 months, then refrigerated storage must be used. Both temperature and humidity control are essential, regardless of whether refrigeration or natural storage is used.

The projected cost of fully refrigerated storage outlined above is $900,000 for facilities and equipment. An additional $900,000 support for management, technical support and inventory would be required. Most of the $900,000 would be needed for inventory financing.

Processing

Farmers in the altiplano exhibit little interest in producing fruits and vegetable crops for processing. They feel strongly that processing prices are lower than fresh market prices. Generally this is true. Their feelings are based on prices processors have offered them, and to promises that were not kept.

In spite of these feelings, there may be opportunities in the future for specialized processing. Study groups should be activated which investigate opportunities

for processed fruit and vegetable projects. The focus of these groups should be on the Central American market, while not ruling out other markets. One avenue of investigation might well be to identify those products which are now being imported by Central American countries.

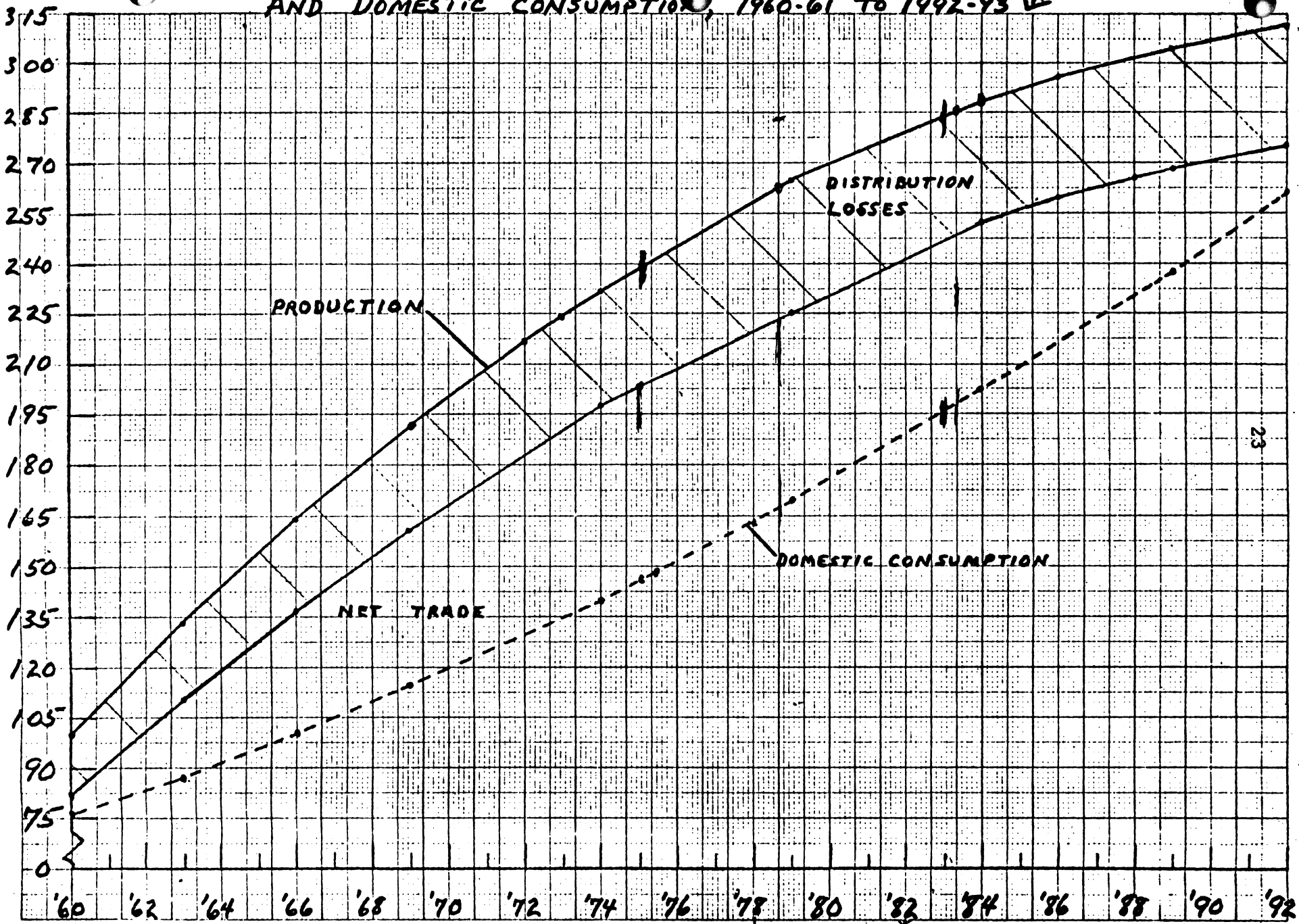
Market development for a new line of processed products is usually long in time and expensive. In addition, distribution systems for processed products are not the same as for fresh market. The facilities and inventory costs are high. The people and companies involved in buying, selling, and distributing processed products are outside the fresh market system.

All of these reasons illustrate why processing was not placed first in a fruit and vegetable marketing system.

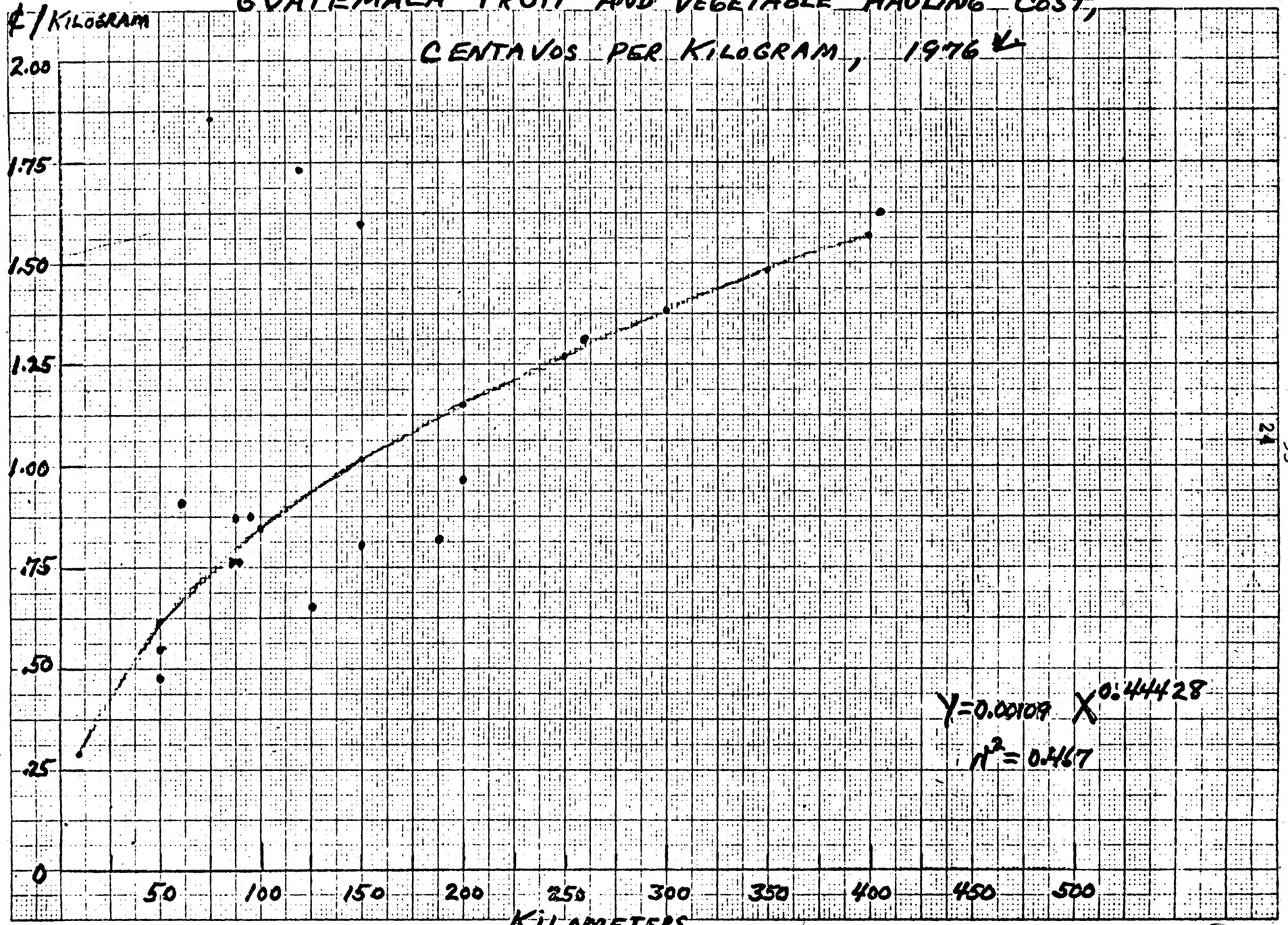
As the proposed marketing cooperative is developed, and as storage is added, processing activities may become more feasible. This is because the organization will develop expertise in accumulating and storing large quantities of fruits and vegetables, with some assurance of a continuing supply. Perhaps more importantly, the small farmer will have developed a trust in the cooperative and its management.

For these reasons, it is suggested that a processing activity be initiated in the 1982-83 period and that $1½ million in loan money be reserved for this time period for this activity. Additional support money of about the same amount will be needed for large inventories. Technical assistance and management training will be needed.

# APPENDIX



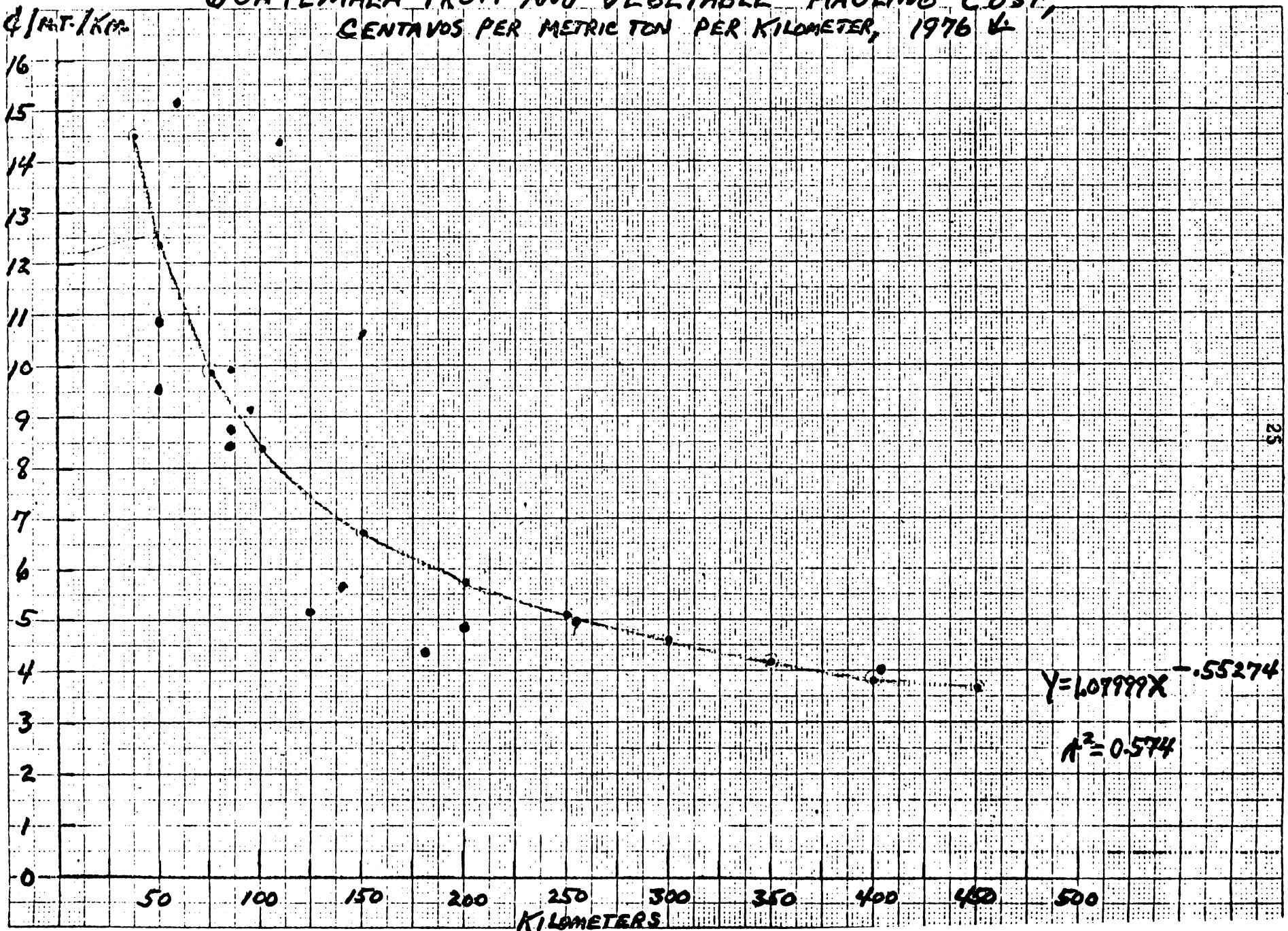

1/ USDA/USAID CALCULATIONS, FEBRUARY 1977.




1/ USDA/USAID CALCULATIONS

# GUATEMALA FRUIT AND VEGETABLE HAULING COST,

## CENTAVOS PER METRIC TON PER KILOMETER, 1976



GUATEMALA TEMPERATE VEGETABLE AND FRUIT PRICES, ESTIMATED PHYSICAL LOSSES AND ADJUSTED MARGINS, DECEMBER 1976 1/

| COMMODITY | PRICES | | | | | ESTIMATED PHYSICAL LOSSES (PERCENT) | | | | | MARGINS AFTER ADJUSTING FOR LOSSES, TOTAL VALUE BASIS (Percent of Consumer Value) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Farm Price | Assembly Buyer | Terminal Buyer ($ /Kg.) | Retail Buyer | Consumer Price | Farm - Assembly | Assembly-Terminal | Terminal-Retail | Retail-Consumer | Total Loss | Farm Share | Farm - Assembly | Assembly-Terminal | Terminal-Retail | Retail-Consumer | Total Marketing |
| Acelga (Chard) | .2400 | .2480 | .2600 | .2995 | .4320 | 2.25 | 4.50 | 5.75 | 12.50 | 25.00 | 74.1 | .7 | -- | 6.1 | 19.1 | 25.9 |
| Ajo (Garlic) | .3026 | .3480 | .4263 | .6105 | 1.2920 | .90 | 1.80 | 2.30 | 5.00 | 10.00 | 26.0 | 3.7 | 6.2 | 14.2 | 50.1 | 74.0 |
| Apio (Celery) | .1630 | .1680 | .1728 | .2700 | .3120 | .72 | 1.44 | 1.84 | 4.00 | 8.00 | 56.8 | 1.3 | .8 | 31.4 | 9.7 | 43.2 |
| Arvejas (Peas) | .3917 | .4309 | .5247 | .8000 | 1.1000 | 1.17 | 2.34 | 2.99 | 6.50 | 13.00 | 40.9 | 3.6 | 8.4 | 25.3 | 21.8 | 59.1 |
| Bretones (Brussell Sprouts) | .0990 | .1493 | .2035 | .4703 | .6734 | 2.43 | 4.86 | 6.21 | 13.50 | 27.00 | 20.2 | 9.5 | 8.7 | 44.4 | 17.2 | 79.8 |
| Broculi (Broccoli) | .0875 | .0900 | .1000 | .1150 | .1700 | 2.25 | 4.50 | 5.75 | 12.50 | 25.00 | 68.6 | .4 | 4.1 | 5.8 | 21.1 | 31.4 |
| Cebolla (Onions) | .0522 | .0626 | .0796 | .1580 | .1992 | .93 | 1.85 | 2.36 | 5.14 | 10.28 | 29.2 | 5.5 | 8.6 | 40.6 | 16.1 | 70.8 |
| Coliflor (Cauliflower) | .1104 | .1161 | .1237 | .1357 | .2720 | 2.00 | 3.00 | 5.00 | 24.00 | 34.00 | 61.5 | 1.9 | 2.1 | 2.6 | 31.9 | 38.5 |
| Ejote (Green Beans) | .2500 | .2875 | .3125 | .3340 | .4180 | 1.17 | 2.34 | 2.99 | 6.50 | 13.00 | 68.7 | 9.4 | 4.8 | 3.0 | 14.1 | 31.3 |
| Esparrago (Asparragus) | 1.1491 | -- | -- | -- | 1.4698 | | 7.00 | | 7.00 | 14.00 | 90.9 | -- | -- | -- | -- | 9.1 |
| Espinaca (Spinach) | .2415 | .2657 | .3514 | .4268 | .5510 | 2.25 | 4.50 | 5.75 | 12.50 | 25.00 | 58.4 | 4.4 | 16.5 | 11.1 | 9.6 | 41.6 |
| Lechuga (Lettuce) | .1367 | .1504 | .1678 | .1896 | .2610 | 2.25 | 4.50 | 5.75 | 12.50 | 25.00 | 69.8 | 5.3 | 4.8 | 4.8 | 15.3 | 30.2 |
| Nabo (Turnips) | .1420 | .1562 | .1736 | .2135 | .3047 | .90 | 1.80 | 2.30 | 5.00 | 10.00 | 51.8 | 4.7 | 5.1 | 12.4 | 26.0 | 48.2 |
| Papa (Potatos) | .0725 | .0757 | .1224 | .1300 | .2200 | .54 | 1.08 | 1.38 | 3.00 | 6.00 | 35.1 | 1.3 | 21.9 | 2.7 | 39.0 | 64.9 |
| Pepino (Cucumber) | .0300 | .0330 | .0473 | .0993 | .1755 | .90 | 1.80 | 2.30 | 5.00 | 10.00 | 19.0 | 1.7 | 8.4 | 30.6 | 40.3 | 81.0 |
| Rabano (Radish) | .3365 | .3870 | .4526 | .6522 | 1.0560 | 1.17 | 2.34 | 2.99 | 6.50 | 13.00 | 36.6 | 5.0 | 5.9 | 18.8 | 33.7 | 63.4 |
| Remolacha(Beets) | .1929 | .2045 | .2219 | .2296 | .3555 | .90 | 1.80 | 2.30 | 5.00 | 10.00 | 60.3 | 3.1 | 4.1 | .7 | 31.8 | 39.7 |
| Repollo (Cabbage) | .0600 | .0790 | .0917 | .1032 | .2400 | .72 | 1.44 | 1.84 | 4.00 | 8.00 | 27.1 | 8.4 | 5.1 | 4.2 | 55.2 | 72.9 |
| Tomate (Tomatoe) | .0678 | .0742 | .0852 | .1440 | .2400 | 2.00 | 4.00 | 5.00 | 11.00 | 22.00 | 36.2 | 2.6 | 3.9 | 25.8 | 31.5 | 63.8 |
| Zanahoria (Carrots) | .1650 | .1700 | .1857 | .1957 | .3500 | 1.08 | 2.16 | 2.76 | 6.00 | 12.00 | 53.6 | 1.0 | 3.8 | 1.4 | 40.2 | 46.4 |
| Aguacate (Avocado) | .0300 | .0402 | .0528 | .1020 | .2211 | 1.00 | 1.75 | 2.25 | 10.00 | 15.00 | 16.0 | 5.2 | 6.2 | 24.2 | 48.4 | 84.0 |
| Ciruela (Plum) | .1766 | .1956 | .2331 | .2663 | .5108 | 1.26 | 2.52 | 3.22 | 7.00 | 14.00 | 40.2 | 3.8 | 7.1 | 5.3 | 43.6 | 59.8 |
| Durazno (Peach) | .1630 | .1848 | .2304 | .2609 | .5131 | 1.26 | 2.52 | 3.22 | 7.00 | 14.00 | 36.9 | 4.4 | 8.9 | 4.7 | 45.0 | 63.1 |
| Frambuesa (Raspberry) | .3500 | -- | -- | -- | .9100 | -- | -- | -- | -- | 15.00 | 45.2 | -- | -- | -- | -- | 54.8 |
| Fresa (Strawberry) | .3375 | .3848 | .4407 | .4757 | .8017 | 1.00 | 1.75 | 2.25 | 10.00 | 15.00 | 49.5 | 6.4 | 7.0 | 3.4 | 33.7 | 50.5 |
| Zarzamora (Blackberry) | .2500 | -- | -- | -- | .8500 | -- | -- | -- | -- | 15.00 | 34.6 | -- | -- | -- | -- | 65.4 |
| Manzana (Apple) | .2400 | .2600 | .2958 | .3400 | .6000 | 1.44 | 2.88 | 3.68 | 8.00 | 16.00 | 47.6 | 3.2 | 5.3 | 6.0 | 37.9 | 52.4 |
| Pera (Pear) | .4000 | .4400 | .5158 | .6200 | .9200 | 1.26 | 2.52 | 3.22 | 7.00 | 14.00 | 50.6 | 4.3 | 7.8 | 10.2 | 27.1 | 49.4 |

1/ USDA/USAID Calculations, January 1977

Dwayne Jelinek

# MARKETING REPORT

## INSTITUTIONAL AND ORGANIZATIONAL ANALYSIS

This draft report, concerned with the institutional and organizational aspects of a marketing system aimed at assisting small-scale producers, has been prepared as part of the larger overall marketing study. The intent of the report is to try to identify the type of organizational structure and the institutions which could implement the overall project goals and objectives. To do this, the report has been divided into three major sections which are:

I. Description of the Existing Marketing System

II. Identification of Problems, Constraints, and Major Issues within the Existing System

III. Definition of a Proposed Marketing Structure (with some alternatives) to Market for Small-Scale Producers

The presentation in Part III represents our best thoughts based on the information available at the present time. Before a final structure is agreed upon, there is need for additional input and reactions from the Cooperative Federations in Guatemala City, regional and local cooperatives, including farmer/members, relevant government institutions, and the private sector. This document should serve as a starting point and a base upon which a final structure can be developed.

In order to keep the analysis manageable, several key commodities which presently have good market acceptability, which are presently produced in the Altiplano region, which are not highly perishable, which produce in less than a year, and which provide reasonable margins to producers were identified. The marketing system for these commodities was then analyzed in detail. Where possible, other commodities were studied so that a general understanding of their marketing systems was obtained. The key commodities chosen were potatoes, cabbage, carrots, onions,

and garlic. Associated with this analysis was the definition of where these crops are produced and the determination of which areas should first be included in the proposed marketing structure. It should be noted that the development of a new marketing entity or structure to handle the selected crops does not mean to imply that other crops are excluded. Other crops can be moved through the new entity and eventually will be. They are not, however, priority crops at this time.

To prepare this document in a short period of time required a large number of meetings with informed individuals both in Guatemala City and in the Altiplano region (the study area). The general categories of individuals and organizations with whom meetings were held include: farmers, farm produce buyers and shippers, wholesalers and retailers within the Guatemala City Terminal market. cooperatives at the national, regional, and local levels, processors, and fresh produce retail distributors such as supermarkets.

## I. DESCRIPTION OF THE EXISTING MARKETING SYSTEM

The general structure of the marketing system for Altiplano vegetables which presently serves small scale producers is illustrated in Figure 1. As can be seen from Figure 1, there are several actions or options available for each marketing step. Also, the quantity of produce following each option varies to some degree according to commodity. An obvious omission from the figure is processing, and it is omitted because no cases of small farmer linkages to the processing function were found.

A breif discussion of each of the marketing steps follow:

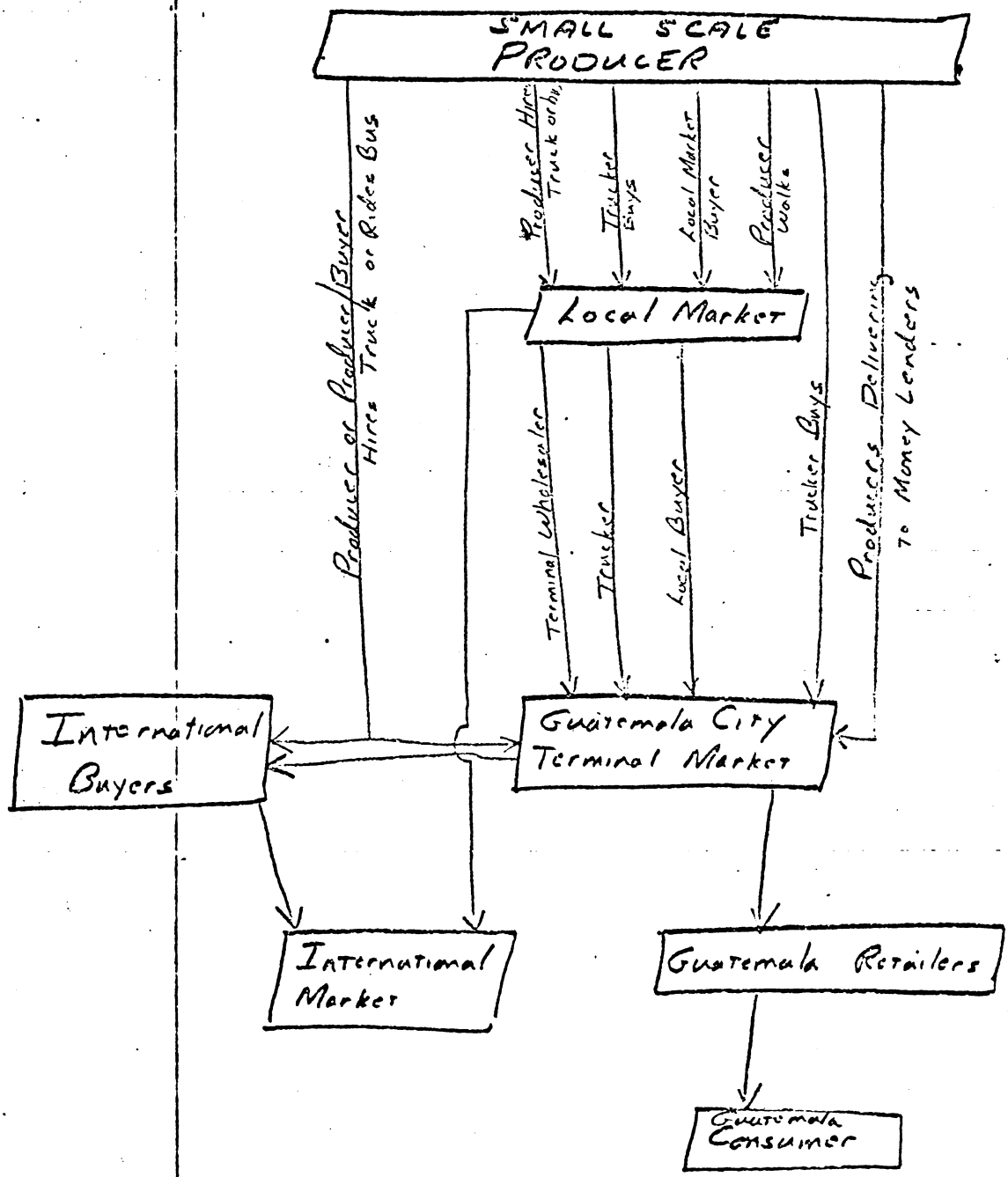
### A. Produce Delivery Direct to Guatemala City Terminal Market or to International Buyers

There are four major ways that this step occurs. (1) A producer or a group of producers hire a truck and bring their produce directly to the Terminal Market

# Figure 1



## General Structure of Marketing System for Altiplano Vegetables Produced by Small Farmers



where they sell their produce individually to Terminal Wholesalers. In some cases, producers will ride a bus with produce on top of bus. They never sell as a group. This procedure for all vegetables. Generally, the product is brought in with no advance notice to the Terminal buyers and a price is agreed upon when the produce arrives. Most products come in on the major market days. Onions are somewhat exceptional in that producers sometimes come to Terminal buyers and negotiate a price and a volume, and the onions are delivered several days later. Small farmers participation in this is not high, however. In most cases, onions are brought in and are purchased by major onion wholesalers from the individual producer. Often in the case of potatoes, producers arrive, are met by buyers (usually buyers they know and are accustomed to dealing with), potatoes are unloaded and put into the buyer's bodega, and a price is agreed upon several hours later after all potatoes for the day have arrived and after most retail buyers have already made their purchases.

Garlic is delivered to the large garlic warehouse where producers sell individually to the large garlic buyers, many of whom are from Aguacatan (as are most producers).

Cabbage and carrots are sold by individuals to any number of the vegetable wholesalers located throughout the Terminal area.

(2) A producer buyers produce from his neighbors or at the local market, hires a truck and sells in the Terminal Market following the same process discussed in (1) above.

(3) A trucker comes to the farmer's field, buys the product there, pays cash, and delivers the product to the Terminal Market generally following the same procedure discussed in (1) above.

(4) In the case of potatoes, some producers deliver directly to several large wholesalers at the Terminal. These producers have received credit or fertilizer from these wholesalers and have agreed to bring their potatoes to these wholesalers. These producers receive a discounted price for their potatoes (usually 1 or 2 Quetzales off the market price per quintal) minus the amount of the credit.

In some cases, the producer, upon arrival at the Terminal Market, will sell directly to any of the international buyers who have their trucks at the market. This is not customary, however, as most international buyers deal with Terminal Wholesalers.

B. Product Delivery to Local Market

There are four procedures for moving produce from the producer to the local market. These are:

(1) The producer, or a group of producers, hires a truck to bring produce to the local area market. The individual producers then sell to local wholesale buyers or they sell directly to consumers coming to the market place. Buses are sometimes used to bring the produce to these markets.

(2) Producers walk to the market place carrying their produce. At the market they sell either to local wholesalers or directly to consumers.

(3) A trucker comes to the producer's farm, buys the produce for cash, and then sells it in the local market place.

(4) Buyers from the local market come to farms in their own or hired trucks, buy the produce for cash, and then sell it in the area market place.

C. Produce Movement from Local Markets to the Guatemala City Terminal Market and Into the International Market

There are four major procedures for moving produce from the local market to the Guatemala City Terminal market into the international market:

(1) Wholesalers from the Terminal market go to local area markets and buy from producers, local dealers, or truckers. These wholesalers bring the produce to Guatemala City in their own trucks or in rented trucks.

(2) Truckers purchase in the local market either for buyers in the Terminal markets, other buyers, or for themselves. When they buy for themselves, they sell in the Terminal Market, and are essentially speculating.

(3) Local buyers buy from producers or from other buyers and they then sell the produce in the Terminal Market. Product transport is usually in a rented truck although some local buyers have their own vehicles.

D. Guatemala City Terminal Market Activities

Once products are sold in the Terminal Market, they are sold to international buyers or to retail purchasers. The retail purchasers represent supermarkets, specialty vegetable shops, other Guatemala City area markets, hotels and restaurants, and retail stalls located in the Terminal Market.

## II. IDENTIFICATION OF MAJOR ISSUES, PROBLEMS AND CONSTRAINTS WITHIN THE EXISTING MARKETING SYSTEM

Throughout the course of the field work and interviews, an attempt was made to define those issues, constraints and problems which need to be taken into account when designing a marketing entity intended to serve small-scale producers.

(1) The small producer almost always sells individually and for cash. He does not participate in the long-term arrangements and relationships which exist in the Terminal Market. He is essentially on the outside of the system, knowing certain actors in the system, dealing with them, buy never really participating in the formal or informal network of complex interrelationships which have been developed to service market needs.

(2) The small producer is accustomed to selling all of his production for one price. Very little grading is done at the farm level and therefore, price differentiation by grade is not a customary practice.

(3) There appears to be no shortage of trucks available for rent, and it is common practice for farmers to rent trucks.

(4) Farmers will work together to rent a truck, but they do not sell as a group - they always sell individually.

(5) There is little trust among farmers when it comes to selling produce. Farmers feel that they must sell their own produce and will not even allow a neighbor to do it for them.

(6) Many rural areas are served by trucks which follow a schedule and a route. For instance, farmers know that they can expect a truck to pass on a certain road on a certain day. These trucks are used by farmers to haul produce to markets with the payment of a freight charge.

(7) Many farmers do not go to the Terminal Market to sell their produce, but others dislike the Terminal and sell locally to avoid going there. This limits their production to those products which can be sold locally.

(8) Special market days exist in all markets - even the Terminal Market. This results in one or two high volume days a week, which appears to have a price depression effect despite the presence of more buyers.

(9) There is almost no storage of any commodity being studied. There is some potato, garlic, and onion storage, but on a very small scale, for a short time, and on the wholesale level. There is none done by the small producer.

(10) Farmers spend a lot of time arranging shipping traveling to market, and in the marketplace. Some potato producers make two trips a week to the Terminal Market.

(11) Attempts by INDECA, FENACOAC, and FEDACOAG to assist farmers in marketing have generally not been successful, and farmers know this. Farmers have heard of other marketing schemes, none of which have been carried out.

(12) Many farmers, because they are living on the margin, and because of past unfulfilled promises, are distrustful of new ideas or schemes. One could expect a very careful scrutiny of a new marketing entity prior to it's acceptance.

(13) Farmers who belong to cooperatives appear to trust their local co-op group and generally stated that they would allow their co-op to market for them. However, co-ops at all levels have no marketing capabilities. Some even stated that they might be willing to wait a week for payment, and some indicated a percentage payment to cover costs would be satisfactory for a while.

(14) There was general agreement among farmers interviewed that a Guatemala City market price minus delivery costs would be acceptable as a marketing entity price. A guaranteed price was preferred, but seen as difficult.

(15) Marketing intelligence system is very poor for farmers. In most areas price information is 2 or 3 days old, and it often comes only via truckers or buyers.

(16) Many farmers interviewed showed a willingness to accept planting and variety suggestions from the marketing organization. The intent of such suggestions would be to plant more marketable crops at times which would allow harvest in an off-peak season.

(17) Some farmers have not tried to improve their marketing activities because they do not understand the whole system and do not feel that they have the time, because of their farming activities, to understand it.

(18) A contract is not considered binding, and there are various examples of broken contracts when market prices go above contract prices.

(19) Opinions on credit vary. Some farmers refuse to use it, others get it through a co-op or BANDESA, and others go to the large wholesalers.

(20) Large price fluctuations can occur in very short periods of time - sometimes in a matter of hours.

(21) Local cooperatives and the central offices of the Federations show an interest in the program, but none want responsibility, due to fear of financial implications and lack of technical expertise.

(22) The terminal market is open to new dealers. Selling space is available for sale or rent, and there are no dominant forces or groups which control the commodities being studied. However, as discussed in the Terminal market paper in the appendix, the informal structure between large producers and wholesale buyers and between wholesalers and retail buyers is quite strong. The relationships are many years old, there is quality and quantity assurance, and there is trust among the participants. It is certainly not impossible to enter the system, but to do so will require quality, punctual delivery of promised quantity, and competitive pricing.

(23) An alternative to the Terminal market would be welcomed by some retail buyers because of the hassle of going there and the general physical condition of the market.

(24) In order to get the necessary production in the required volume with necessary quality will require close coordination with producers as well as technical assistance for them.

(25) The overall marketing situation is quite complex with many actors at and between all of the major steps within the system. To deal with this system will require a great deal of flexibility, as well as personnel who are imtimately acquainted with all steps in the system and who know who the actors are. Personnel knowledge of small farmers, truckers, local markets, the terminal market (at all

levels), international market and buyers, and purchasers for retailers in Guatemala City (buyers for supermarkets, specialty vegetable shops, hotels and restaurants, etc.) will be required. Ideally, these would be people with actual practical knowledge of and experience with the system.

Chilling Injury
Certain fruits and vegetables are injured by low (32°-50°F) but non freezing temperatures.



At these temperatures they become weakened because they are unable to carry on normal metabolic processes. Often products that are chilled look sound when removed from low temperatures. However, symptoms of chilling, such as pitting or other skin blemishes, internal discoloration, or failure to ripen, become evident in a few days at warmer temperatures. Susceptible fruits and vegetables that have been chilled may be particularly susceptible to decay. Alternaria rot is often severe on tomatoes (*389*), squash (*386*), peppers (*387*), and cantaloups that have been chilled. Both time and temperature are involved in chilling injury. Damage may occur in a short time if temperatures are considerably below the danger line, but a product may be able to withstand a few degrees in the danger zone for a longer time. However, with some products (for example, grapefruit and cucumbers) injury may become apparent sooner at temperatures only slightly below the optimum than at lower temperatures (*139*, *709*). The effects of chilling are cumulative. Low temperatures in transit, or even in the field shortly before harvest, add to the total effects of chilling that might occur in storage. Chilling injury, if a factor in storage, is discussed under each commodity. Many of the commodities susceptible to chilling injury are listed in table 5 together with some of the symptoms. (See also *384*, *487*.)

## Freezing Injury

The temperatures usually recommended for storing fresh commodities that are not susceptible to chilling injury are slightly above the freezing point, as shown in tables 6, 11, and 13. The highest temperature at which freezing (temperatures at which ice crystals form in the tissues of the various commodities) may occur is given. In the previous edition of this handbook, the average freezing point was given, which is usually somewhat lower. It is felt that the highest freezing point is a better guide for commodities that are damaged by freezing. For a discussion of freezing points and the factors affecting them, see (*739*).

Tissues injured by freezing generally appear water soaked. Complete descriptions of freezing injury are found in U.S. Department of Agriculture publications on market diseases (*253*, *522*, *523*, *524*, *525*, *537*, *541*, *608*).

Different commodities vary widely in their susceptibility to freezing injury. Some may be frozen and thawed a number of times with little or no injury; whereas, others are permanently injured by even slight freezing. The freezing point of the commodity is no indication of the damage to be expected by freezing or chilling. For example, tomatoes and parsnips both have freezing points of 30° to 31° F.; but parsnips can be frozen and thawed several times without apparent injury,

TABLE 5.—*Fruits and vegetables susceptible to chilling injury when stored at moderately low but nonfreezing temperatures*

| Commodity | Approximate lowest safe temperature | Character of injury when stored between 32° F. and safe temperature [1] |
|---|---|---|
| | °F. | |
| Apples—certain varieties. | [2] 36–38 | Internal browning, brown core, soggy breakdown, soft scald. |
| Avocados | [2] 40–55 | Grayish-brown discoloration of flesh. |
| Bananas, green or ripe. | [2] 53–56 | Dull color when ripened. |
| Beans (snap) | [2] 45 | Pitting and russeting. |
| Cranberries | 36 | Rubbery texture, red flesh. |
| Cucumbers | 45 | Pitting, water-soaked spots, decay. |
| Eggplants | 45 | Surface scald, alternaria rot. |
| Grapefruit | [2] 50 | Scald, pitting, watery breakdown. |
| Lemons | (?) | Pitting, membranous staining, red blotch. |
| Limes | 45–48 | Pitting. |
| Mangos | [2] 50–55 | Grayish scaldlike discoloration of skin, uneven ripening. |
| Melons: | | |
| Cantaloups | (?) | Pitting, surface decay. |
| Honey Dew | 45–50 | Pitting, surface decay, failure to ripen. |
| Casaba | 45–50 | Do. |
| Crenshaw and Persian. | 45–50 | Do. |
| Watermelons | 40 | Pitting, objectionable flavor. |
| Okra | 45 | Discoloration, water-soaked areas, pitting, decay. |
| Olives, fresh | 45 | Internal browning. |
| Oranges, California and Arizona. | [2] 38 | Pitting, brown stain. |
| Papayas | 45 | Pitting, failure to ripen, off flavor, decay. |
| Peppers, sweet | 45 | Sheet pitting, alternaria rot on pods and calyxes. |
| Pineapples | [2] 45–50 | Dull-green when ripened. |
| Potatoes | 38 | Mahogany browning (Chippewa and Sebago), sweetening.[2] |
| Pumpkins and hardshell squashes. | 50 | Decay, especially alternaria rot. |
| Sweetpotatoes | 55 | Decay, pitting, internal discoloration. |
| Tomatoes: | | |
| Ripe | [2] 45–50 | Watersoaking and softening, decay. |
| Mature-green | 55 | Poor color when ripe; alternaria rot. |

[1] Often these symptoms are apparent only after removal to warm temperatures, as in marketing.
[2] See text.

whereas tomatoes are ruined after one freezing. As with chilling injury, severity of freezing injury is influenced by a combination of time and temperature. Apples that would be injured little by exposure for a few days at temperatures slightly below the freezing point would be severely injured by just a few hours' exposure to 15° to 20°.

The following tabulation gives the relative susceptibility of a number of commodities to actual freezing injury. The commodities are arranged somewhat arbitrarily into three groups: (1) most susceptible, those that are likely to be injured by even one light freezing; (2) moderately susceptible, those that will recover from one or two light freezings; (3) least susceptible, those that can be lightly frozen several times without serious damage. Even though a number of commodities are somewhat tolerant to freezing, it is desirable to avoid subjecting them to freezing temperatures. Often the storage life is shortened by freezing. Apples that recover from freezing are softer than normal fruit; hence, they should be marketed quickly. Carrots that have been frozen are especially subject to decay.

**Susceptibility of Fresh Fruits and Vegetables to Freezing Injury**

| Group 1 Most susceptible | Group 2 Moderately susceptible | Group 3 Least susceptible |
|---|---|---|
| Apricots | Apples | Beets [1] |
| Asparagus | Broccoli, sprouting | Brussels sprouts |
| Avocados | Cabbage, new | Cabbage, old and savoy |
| Bananas | Carrots [1] | Dates |
| Beans, snap | Cauliflower | Kale |
| Berries (except cranberries) | Celery | Kohlrabi |
| Cucumbers | Cranberries | Parsnips |
| Eggplant | Grapefruit | Rutabagas |
| Lemons | Grapes | Salsify |
| Lettuce | Onions (dry) | Turnips [1] |
| Limes | Oranges | |
| Okra | Parsley | |
| Peaches | Pears | |
| Peppers, sweet | Peas | |
| Plums | Radishes [1] | |
| Potatoes | Spinach | |
| Squash, summer | Squash, winter | |
| Sweetpotatoes | | |
| Tomatoes | | |

[1] Without tops.

Most fresh fruits and vegetables, when left undisturbed, usually can be cooled one to several degrees below their freezing point before freezing actually occurs. This is known as *undercooling* or *supercooling*. They may remain undercooled for several hours, but if jarred or moved freezing usually starts immediately.

Fresh commodities should not be handled while frozen. If permitted to warm above the freezing point, it is possible that many specimens that were undercooled may escape having ice crystals form in them. Even potatoes, which are very sensitive to freezing damage, have been undercooled for a short time to 25° F.—about 5° below their freezing point—and then carefully warmed with no freezing symptoms occurring (*284*). Plant tissue is very sensitive to bruising while frozen, which is another reason for leaving commodities undisturbed until they have warmed up. Selection of a suitable thawing temperature involves a compromise. Fast thawing damages tissue, but very slow thawing such as at 32° or 33° permits ice to remain in the tissues too long. Thawing at 40° is suggested (*194*, *369*).

(See also *60*, *384*, *542*.)

## Ammonia Injury

Damage from escaping ammonia sometimes occurs to products in storage where direct-expansion refrigeration systems are used. Slight injury may be indicated by brown to greenish-black discoloration of the outer tissues of fruits and vegetables. In apples and pears the tissue around the lenticels is discolored. Severe injury may be marked by discoloration and softening of the deeper tissues, which render the products unmarketable.

An ammonia concentration of 0.8 percent caused rather severe injury to apples, pears, bananas, peaches, and onions within an hour (*521*). Grapes were injured by a 1-hour exposure and almonds and filberts by a ½-hour exposure to 1 percent ammonia. Concentrations that were barely detectable by odor (0.01 percent) caused darkening of the skins of shelled pecans in 15 minutes and of almond shells in 1 hour (*536*). Peaches are particularly sensitive to ammonia gas; even 0.02 percent for 6 hours caused slight injury (*63*). Daily odor checks for ammonia leaks are desirable precautions. Installation of an ammonia alarm system may be advisable.

Ammonia fumes are best removed from storage rooms by aeration and washing the contaminated atmosphere with water where this is possible. Apples sometimes recover with only minor injury at the lenticels if the aeration is quick and complete (*635*). Sulfur dioxide serves as a satisfactory neutralizing agent for light ammonia damage to commodities that are tolerant to sulfur dioxide, such as grapes, almonds, and filberts (*121*). Concentration of sulfur dioxide should be less than 1 percent for grapes and less than 5 percent for almonds and filberts. This treatment is unsatisfactory for pecans, sweet cherries, nectarines, Santa Rosa plums, peaches, pears, and walnuts.

As far as is known, refrigerant R–12 is not injurious to fresh fruits and vegetables.

(See also *520*.)

### Effect of Cold Storage on Subsequent Behavior of Fruits and Vegetables

There is a belief that cold storage predisposes fruits and vegetables to rapid deterioration after removal, but there is no evidence to support this viewpoint except in instances of over-refrigeration of those products that are sensitive to cold. At unrefrigerated temperatures most commodities usually age quickly and spoilage soon occurs. At refrigerated temperatures aging and decay are greatly retarded; the net result is longer life. As some of the potential life is used up in storage, it is not reasonable to expect the commodity to keep so long after removal as freshly harvested produce. But if the correct temperature and humidity are used and suitable storage periods are not exceeded, there will be sufficient time for the commodity to pass through normal marketing channels after removal. Fruits and vegetables that are used immediately after storage (as on board ship or for canning) can often be held slightly longer than the recommended time. Exceptions are commodities, such as peaches and most varieties of pears, that need to be ripened after removal from storage. These will fail to ripen properly if stored too long. Extremely perishable fruits and vegetables have a short storage life and must be used soon after they are taken from storage. There is no evidence to indicate that fruits and vegetables suffer from a shock effect when removed from cold storage to room temperature.

When fruits or vegetables are removed from a low temperature to a higher one, moisture often condenses from the air on the cool surface of the commodity. This is known as sweating; the higher the relative humidity of the outside air, the more marked it becomes. This is because the dewpoint of the air is at or above the temperature of the commodity. Sweating should be prevented or minimized whenever possible, particularly with onions and the more tender fruits, because it may favor decay. This does not mean that when products sweat after removal from a refrigerated room they will decay; it does mean that conditions are more favorable for decay than if the surfaces remain dry until consumed. However, as far as is known, experimental evidence does not indicate that sweating is actually harmful. Sweating did not increase decay of papayas when they were transferred to a higher temperature for several hours during the storage period (*8*).

Sweating can be prevented to some extent by allowing fruits and vegetables to warm gradually. Usually if the commodity is moved from a 32° F. storage to temperatures of only 50° or 55°, little or no condensation occurs. Under commercial conditions, however, such precautions are rarely practical. If possible, products should be removed from storage when the relative humidity of the outside air is low. Ordinarily, the best procedure in very damp weather is to handle the product carefully and get it into consumption without undue delay. Air movement over the product while it is warming is helpful in drying the surface. Usually no harm is done if the product remains moist for only a short time. The possibility of sweating when products are removed from cold storage should not deter one from using recommended storage temperatures. The deleterious effects of too high a temperature are much greater than any possible effects of sweating.

## MIXED COMMODITIES

At times it may be necessary to store different products together. This may or may not be safe. Deciduous fruits can generally be stored together if they have the same temperature requirements. With some products there is a cross-transfer of odors. Also volatiles such as ethylene are emitted by some products that may be harmful to others. Combinations that should be avoided in storage rooms are apples or pears with celery, cabbage, carrots, potatoes, or onions; celery with onions or carrots; and citrus fruit with any of the strongly scented vegetables. Odors from apples and citrus fruits are readily absorbed by meat, eggs, and dairy products. Pears and apples acquire an unpleasant earthy taste and odor when stored with potatoes. It is recommended that onions, nuts, citrus fruit, and potatoes each be stored separately. (See *59*, *293*.)

Lettuce, carrots, some nursery stock, and some kinds of flowers and greens are damaged when stored with apples, pears, and many other fruits and some vegetables because of the ethylene that is given off from these products as a natural emanation. Very low concentrations may produce adverse effects. Susceptible kinds of flowers are particularly sensitive to ethylene. Therefore, they should not be stored in the same building in which ethylene-producing products, particularly apples and pears, are stored. (See ethylene section under flowers, p. 63.) Bananas, avacados, peaches, plums, cantaloups, ripe Honey Dew melons, and tomatoes are among other fruits and vegetables that give off ethylene (*51*, *72*, *73*, *444*). *Penicillium digitatum* (green mold of citrus) and probably other decay organisms also produce ethylene (*49*, *72*). Apparently all fleshy fruits give off some ethylene (*72*).

Ethylene also stimulates ripening of many fruits and vegetables. This ripening effect is negligible

at low temperatures (e.g., 32° F.), but it may have an effect at higher temperatures. For this reason products such as cucumbers, peppers, and acorn squash, in which retention of green color is desirable and which need to be stored at 45° to 50°, should not be stored with apples, pears, tomatoes, or other ethylene-producing crops.

Discussions of the production of ethylene and its role in the postharvest physiology of fruits and vegetables are contained in (*51, 73, 444, 510*).

## FRESH FRUITS

The recommended storage requirements, approximate length of storage period, and freezing point for the commercial storage of fresh fruits are given in table 6. Detailed descriptions of the storage requirements are given in the text. Water content and specific heat are also given in table 6.

TABLE 6.—*Recommended temperature and relative humidity, approximate storage life, highest freezing point, water content, and specific heat of fresh fruits in commercial storage*

| Commodity | Temperature [1] | Relative humidity | Approximate length of storage period | Highest freezing point [2] | Water content | Specific heat [3] |
|---|---|---|---|---|---|---|
| | *° F.* | *Percent* | | *° F.* | *Percent* | *B.t.u./lb./° F.* |
| Apples | [4] 30–40 | 90 | 3–8 months | 29.3 | 84.1 | 0.87 |
| Apricots | 31–32 | 90 | 1–2 weeks | 30.1 | 85.4 | .88 |
| Avocados | [4] 40–55 | 85–90 | 2–4 weeks [4] | 31.5 | 65.4 | .72 |
| Bananas | [4] 56–58 | [5] 90–95 | ([5]) | 30.6 | 74.8 | .80 |
| Berries: | | | | | | |
| Blackberries | 31–32 | 90–95 | 2–3 days | 30.5 | 84.8 | .88 |
| Blueberries | 31–32 | 90–95 | 2 weeks | 29.7 | 82.3 | .86 |
| Cranberries | [5] 36–40 | 90–95 | 2–4 months [5] | 30.4 | 87.4 | .90 |
| Currants | 31–32 | 90–95 | 1–2 weeks | 30.2 | 84.7 | .88 |
| Dewberries | 31–32 | 90–95 | 2–3 days | 29.7 | 84.5 | .88 |
| Elderberries | 31–32 | 90–95 | 1–2 weeks | ------ | 79.8 | .84 |
| Gooseberries | 31–32 | 90–95 | 2–4 weeks | 30.0 | 88.9 | .91 |
| Loganberries | 31–32 | 90–95 | 2–3 days | 29.7 | 83.0 | .86 |
| Raspberries | 31–32 | 90–95 | ----do | 30.0 | 80.6 | .85 |
| Strawberries | 32 | 90–95 | 5–7 days | 30.6 | 89.9 | .92 |
| Cherries, sour | 32 | 90–95 | 3–7 days | 29.0 | 83.7 | .87 |
| Cherries, sweet | 30–31 | 90–95 | 2–3 weeks | 28.8 | 80.4 | .84 |
| Coconuts | 32–35 | 80–85 | 1–2 months | 30.4 | 46.9 | .58 |
| Dates | [4] 0 or 32 | 75 or less | 6–12 months [4] | 3.7 | 20.0 | .36 |
| Figs, fresh | 31–32 | 85–90 | 7–10 days | 27.6 | 78.0 | .82 |
| Grapefruit, California and Arizona | 58–60 | 85–90 | 4–6 weeks | ------ | 88.8 | .91 |
| Grapefruit, Florida and Texas | [5] 50 | 85–90 | ----do | 30.0 | 88.8 | .91 |
| Grapes, Vinifera | 30–31 | 90–95 | 3–6 months | 28.1 | 81.6 | .85 |
| Grapes, American | 31–32 | 85 | 2–8 weeks [4] | 29.7 | 81.9 | .86 |
| Guavas | 45–50 | 90 | 2–3 weeks | ------ | 83.0 | .86 |
| Lemons | ([5]) | 85–90 | 1–6 months [5] | 29.4 | 89.3 | .91 |
| Limes | 48–50 | 85–90 | 6–8 weeks [5] | 29.1 | 86.0 | .89 |
| Lychees | 35 | 90–95 | 3–5 weeks | ------ | 81.9 | .86 |
| Mangos | [5] 55 | 85–90 | 2–3 weeks | 30.3 | 81.4 | .85 |
| Nectarines | 31–32 | 90 | 2–4 weeks | 30.4 | 81.8 | .85 |
| Olives, fresh | [5] 45–50 | 85–90 | 4–6 weeks [5] | 29.4 | 75.2 | .80 |
| Oranges, California and Arizona | [5] 38–48 | 85–90 | 3–8 weeks [5] | 29.7 | 87.2 | .90 |
| Oranges, Florida and Texas | 32 | 85–90 | 8–12 weeks | 30.6 | 87.2 | .90 |
| Papayas | 45 | 85–90 | 1–3 weeks | 30.4 | 90.8 | .93 |
| Peaches | 31–32 | 90 | 2–4 weeks [4] | 30.3 | 89.1 | .91 |
| Pears | 29–31 | 90–95 | 2–7 months [4] | 29.2 | 82.7 | .86 |
| Persimmons, Japanese | 30 | 90 | 3–4 months | 28.1 | 78.2 | .83 |
| Pineapples | [5] 45–55 | 85–90 | 2–4 weeks [5] | 30.0 | 85.3 | .88 |
| Plums and prunes | 31–32 | 90–95 | 2–4 weeks [4] | 30.5 | 85.7 | .89 |
| Pomegranates | 32 | 90 | ----do | 26.6 | 82.3 | .86 |
| Quinces | 31–32 | 90 | 2–3 months | 28.4 | 85.3 | .88 |
| Tangerines, Temple oranges, and related citrus fruits. | [4] 32–38 | 85–90 | 2–4 weeks | 30.1 | 87.3 | .90 |

[1] Recommended storage temperature; temperature for ripening certain fruits are given in text.

[2] Highest freezing points are from Whiteman (*739*).

[3] Specific heat above freezing was calculated from Siebel's (*600*) formula: S=0.008 (percent water in food)+0.20.

[4] See text for variety differences.

[5] See text.

## Apples

(Temperature 30° to 40° F., see text; relative humidity, 90 percent)

More apples are stored on a tonnage basis than any other fruit, and the average storage period is longer. Apples are now available the year round.

The storage life of apples varies widely. Variety (table 7), production area, cultural practices, seasonal climatic conditions, maturity when picked, and handling and storage practices affect the storage life. Maturity is particularly important. For maximum storage life, apples must be harvested when mature but not fully ripe (see table 7). Immature apples have poor eating quality and are likely to shrivel in storage. They are also more susceptible to storage disorders such as scald (*190, 428, 633, 645, 700*) and bitter pit (*46, 176, 427, 541, 629, 637*).

Apples picked when too mature, on the other hand, are soft, will develop breakdown soon, and have a short storage life. Water core increases in apples that remain on the tree after reaching optimum maturity. Slight water core may disappear in cold storage, but moderate to severe water core usually will not. The disorder shortens the storage life of the fruit and eventually results in breakdown (*52, 541*). If water core is moderate to severe in any lot of fruit, it should be marketed early.

The use of preharvest sprays of growth regulators to control dropping makes it possible to delay harvesting to obtain more size and better color. If, however, the delay in harvesting afforded by sprays extends beyond optimum maturity, the storage potential of the apples will be markedly reduced.

Recommended storage temperature for each variety is that which is most effective in retarding ripening and growth of decay-producing organisms and in avoiding low-temperature disorders. For most apple varieties, the optimum storage temperature is 30° to 32° F. with 90 percent relative humidity. The highest freezing point for apples is about 29.3°; hence, apples can be stored at temperatures of 30° or above. For many varieties, fruit stored at 30° (fruit temperature) will have approximately 25 percent longer storage life than fruit stored at 32°. Higher storage temperatures reduce storage life still further. Fruit temperature is more important than air temperature. Fruit temperatures within stacks of fruit often are several degrees higher than the air temperature as shown by an aisle thermometer. The warmest fruit after cooling should not be above 32° and the coldest not below 30° (fruit temperature). The use of thermocouples placed in the air and in fruit at scattered locations in the storage is desirable. With this equipment accurate fruit temperatures can be determined at any time throughout the room. This removes the risk of relying on air-temperature readings from a single thermometer. If cold spots exist, fans placed in these areas can speed air movement and prevent excessive cooling. The relation of temperature and heat evolution for several apple varieties is given in table 8.

Somewhat higher temperatures than 30° to 32° F. are recommended for some varieties, because of their susceptibility to disorders induced by low temperature. In certain seasons and certain areas these low-temperature disorders may be more se-

TABLE 7.—*Normal and maximum storage for certain apple varieties and their susceptibility to storage disorders*

| Variety | Storage period | | Disorders likely to occur in storage [2] |
|---|---|---|---|
| | Normal | Maximum [1] | |
| | *Months* | *Months* | |
| Baldwin | 4 to 5 | 6 to 7 | Bitter pit, scald, brown core. |
| Cortland | 3 to 4 | 5 to 6 | Scald. |
| Delicious | 3 to 4 | 8 | Internal breakdown, bitter pit, scald, soft scald. |
| Golden Delicious. | 3 to 4 | 6 to 8 | Shriveling, soggy breakdown. |
| Gravenstein | 0 to 2 | 3 | Bitter pit, Jonathan spot, scald. |
| Grimes Golden | 2 to 3 | 4 | Scald, bitter pit, internal breakdown, soggy breakdown. |
| Jonathan | 2 to 3 | 5 to 6 | Jonathan spot, soft scald, internal breakdown. |
| McIntosh | 2 to 4 | 6 to 8 | Brown core, scald. |
| Northern Spy | 4 to 5 | 8 | Bitter pit, Jonathan spot. |
| Rhode Island Greening. | 3 to 4 | 6 to 7 | Scald, bitter pit, brown core. |
| Rome Beauty | 4 to 5 | 6 to 8 | Scald, Jonathan spot. |
| Stayman | 4 to 5 | 6 to 8 | Scald, internal breakdown, bitter pit. |
| Wealthy | 0 to 2 | 3 | Soft scald, Jonathan spot, scald. |
| Winesap | 5 to 6 | 8 | Scald, internal breakdown, shriveling. |
| Yellow Newtown. | 5 to 6 | 8 | Internal browning, scald, bitter pit, Jonathan spot. |
| York Imperial | 4 to 5 | 6 to 7 | Scald, bitter pit. |

[1] For maximum storage, varieties must be harvested at optimum maturity and stored under ideal temperature and humidity conditions. Controlled atmosphere storage is necessary for maximum storage of McIntosh, Cortland, Jonathan, Yellow Newtown, and some other varieties. Some fruit may be stored 1–2 months longer than shown. Polyethylene liners or covers are needed for maximum storage of Golden Delicious.

[2] Water core is not listed for Delicious, Winesap, Jonathan, Stayman, and others, as it is present at harvest and does not develop in storage.

TABLE 8.—*Rates of evolution of heat by 10 apple varieties* [1]

| Variety | B.t.u. per ton per 24 hours at indicated temperature— | | | | |
|---|---|---|---|---|---|
| | 30° F. | 32° F. | 36° F. | 38° F. | 40° F. |
| Delicious | 690 | 760 | 910 | 1,010 | 1,110 |
| Golden Delicious | 730 | 800 | 970 | 1,070 | 1,180 |
| Jonathan | 800 | 880 | 1,060 | 1,170 | 1,290 |
| McIntosh | 730 | 800 | 970 | 1,070 | 1,180 |
| Northern Spy | 820 | 900 | 1,090 | 1,200 | 1,320 |
| Rome Beauty | 530 | 580 | 700 | 780 | 850 |
| Stayman Winesap | 820 | 910 | 1,100 | 1,210 | 1,330 |
| Winesap | 530 | 590 | 710 | 780 | 860 |
| Yellow Newtown | 510 | 570 | 690 | 760 | 840 |
| York Imperial | 610 | 670 | 810 | 900 | 990 |
| Mean | 680 | 750 | 900 | 1,000 | 1,100 |

[1] Adopted from the data of Tolle (*677*).

rious than in others. Jonathan apples from some areas often develop much soft scald in regular cold storage at 32°; therefore, they should be stored at 35° to 36°. McIntosh apples often develop brown core during extended storage at 32°; hence, they should be stored at 38°. Yellow Newtown apples grown in California often develop internal browning stored at 32°; they should be stored at 38° to 40°. Grimes Golden apples are usually stored at 30° to 32°, but when they are grown in some areas they should be stored at 34° to 36° to avoid soggy breakdown.

Unfortunately, fruit ripening is much faster at the warmer temperatures and storage life is reduced. Decay and other disorders, such as Jonathan spot and bitter pit, may be worse at storage temperatures higher than 30° to 32° F. Controlled-atmosphere storage is the main commercial method of compensating for the higher storage temperature required for McIntosh and Yellow Newtown. Storage of Jonathan apples in controlled-atmosphere rooms at 32° provides good control of soft scald and Jonathan spot.

Apples in controlled-atmosphere (CA) storage respire, ripen, and soften more slowly than those in ordinary storage. Consequently, CA fruit has a longer storage life and shelf life after removal from storage than fruit stored in air. The storage life of McIntosh in CA may be doubled over that in regular cold storage.

In CA rooms for apples, an atmosphere of 2 to 3 percent oxygen, 1 to 8 percent carbon dioxide, and the rest nitrogen is carefully maintained. Recommendations for oxygen, carbon dioxide, and CA storage temperature are given for different varieties of apples in table 9. A high relative humidity of 95 percent is recommended in CA rooms.

Great expansion in CA storage capacity for apples occurred in the United States during 1960 to 1966. The pioneering research on CA by Kidd and West (*314, 315, 735*) in England, Smock (*631*) and Van Doren (*719*) in the United States, and others (*141, 152, 470, 636, 647*) and commercial development of generators that produce desired atmospheres (*125,300*) contributed to the expansion.

Although CA storage produces most striking benefits to McIntosh, Jonathan, and Yellow Newtown varieties, which develop low-temperature disorders in regular cold storage, it also benefits other varieties but to a lesser degree. Among these are Delicious, Golden Delicious, Rome Beauty, and Stayman. Controlled-atmosphere storage cannot be expected to have so much effect on apples that store satisfactorily at 30° to 31° F. because of the very low metabolic rate at this temperature. In some

TABLE 9.—*Oxygen, carbon dioxide, and temperature requirements for controlled atmosphere storage of apples* [1]

| Variety | Carbon dioxide | Oxygen | Temperature |
|---|---|---|---|
| | *Percent* | *Percent* | *° F.* |
| Cortland | [2] 2–5 | 3 | 38 |
| Delicious [3] | 1–2 | 2–3 | 30–32 |
| Golden Delicious [3] | 1–2 | 2–3 | 30–32 |
| Jonathan | 3–5 | 3 | 32 |
| McIntosh | [2] 2–5 | 3 | 38 |
| Northern Spy | 2–3 | 3 | 32 |
| Rome Beauty | 2–3 | 3 | 30–32 |
| Stayman | 2–3 | 3 | 30–32 |
| Yellow Newtown | 7–8 | 2–3 | 38–40 |

[1] Adapted from Smock (*631, 634*) and Schomer (*580*).

[2] Cortland and McIntosh varieties are stored in 2 percent carbon dioxide the first month and 5 percent thereafter.

[3] In Washington State, 1–3 percent oxygen is recommended for Delicious and Golden Delicious varieties, rather than 2–3 percent oxygen.

badly and are more likely to decay than if kept in a moist atmosphere. (See *684.*)

## Asparagus

(Temperature, 32° to 36° F.; relative humidity, 95 percent)

Fresh asparagus is usually not stored except temporarily when the market is overstocked. It can be kept successfully for about 3 weeks at 36° F. (fig. 4).[6] After a 5- to 7-day transit period, the safe storage period would be substantially less. If the storage period is to be 10 days or less, 32° is recommended; asparagus is subject to chilling injury if

[6] Data on asparagus in figure 4 are adapted from: LIPTON, W. J. PHYSIOLOGICAL CHANGES IN HARVESTED ASPARAGUS (*Asparagus officinalis*) AS RELATED TO TEMPERATURE OF HOLDING. Ph. D. thesis, Univ. Calif., 116 pp. 1957.

TABLE 11.—*Recommended temperature and relative humidity, approximate storage life, highest freezing point, water content, and specific heat for fresh vegetables in commercial storage*

| Commodity | Temperature | Relative humidity | Approximate length of storage period | Highest freezing point [1] | Water content | Specific heat [2] |
|---|---|---|---|---|---|---|
| | °F. | Percent | | °F. | Percent | B.t.u./lb./°F. |
| Artichokes, globe | 32 | 90–95 | 1 month | 29.9 | 83.7 | 0.87 |
| Artichokes, Jerusalem | 31–32 | 90–95 | 2–5 months | ---- | 79.8 | .84 |
| Asparagus | [3] 32–36 | 95 | 2–3 weeks | 30.9 | 93.0 | .94 |
| Beans, green, or snap | [3] 40–45 | 90–95 | 7–10 days | 30.7 | 88.9 | .91 |
| Beans, lima | [3] 32–40 | 90 | 1–2 weeks [3] | 31.0 | 66.5 | .73 |
| Beets, bunched | 32 | 95 | 10–14 days | 31.3 | ---- | ---- |
| Beets, topped | 32 | 95 | 3–5 months | 30.3 | 87.6 | .90 |
| Broccoli, sprouting | 32 | 90–95 | 10–14 days | 30.9 | 89.9 | .92 |
| Brussels sprouts | 32 | 90–95 | 3–5 weeks | 30.5 | 84.9 | .88 |
| Cabbage, early | 32 | 90–95 | 3–6 weeks | 30.4 | 92.4 | .94 |
| Cabbage, late | 32 | 90–95 | 3–4 months | 30.4 | 92.4 | .94 |
| Cabbage, Chinese | 32 | 90–95 | 1–2 months | ---- | 95.0 | .96 |
| Carrots, mature (topped) | 32 | 90–95 | 4–5 months | 29.5 | 88.2 | .91 |
| Carrots, immature (topped) | 32 | 90–95 | 4–6 weeks | 29.5 | 88.2 | .91 |
| Cauliflower | 32 | 90–95 | 2–4 weeks | 30.6 | 91.7 | .93 |
| Celeriac | 32 | 90–95 | 3–4 months | 30.3 | 88.4 | .91 |
| Celery | 32 | 90–95 | 2–3 months | 31.1 | 93.7 | .95 |
| Collards | 32 | 90–95 | 10–14 days | 30.6 | 86.9 | .90 |
| Corn, sweet | 32 | 90–95 | 4–8 days | 30.9 | 73.9 | .79 |
| Cucumbers | 45–50 | 90–95 | 10–14 days | 31.1 | 96.1 | .97 |
| Eggplants | 45–50 | 90 | 1 week | 30.6 | 92.7 | .94 |
| Endive and escarole | 32 | 90–95 | 2–3 weeks | 31.9 | 93.1 | .95 |
| Garlic, dry | 32 | 65–70 | 6–7 months | 30.5 | 61.3 | .69 |
| Ginger rhizomes | 55 | 65 | 6 months | ---- | 87.0 | .90 |
| Greens, leafy | 32 | 90–95 | 10–14 days | ---- | ---- | ---- |
| Horseradish | 30–32 | 90–95 | 10–12 months | 28.7 | 74.6 | .80 |
| Kale | 32 | 90–95 | 10–14 days | 31.1 | 86.6 | .89 |
| Kohlrabi | 32 | 90–95 | 2–4 weeks | 30.2 | 90.3 | .92 |
| Leeks, green | 32 | 90–95 | 1–3 months | 30.7 | 85.4 | .88 |
| Lettuce | 32 | 95 | 2–3 weeks | 31.7 | 94.8 | .96 |
| Melons: | | | | | | |
| Cantaloup (¾-slip) | 36–40 | 85–90 | 15 days | 29.9 | 92.0 | .94 |
| Cantaloup (full-slip) | 32–35 | 85–90 | 5–14 days | 29.9 | 92.0 | .94 |
| Casaba | 45–50 | 85–90 | 4–6 weeks | 30.1 | 92.7 | .94 |
| Crenshaw | 45–50 | 85–90 | 2 weeks | 30.1 | 92.7 | .94 |
| Honey Dew | 45–50 | 85–90 | 3–4 weeks | 30.3 | 92.6 | .94 |
| Persian | 45–50 | 85–90 | 2 weeks | 30.5 | 92.7 | .94 |
| Watermelon | [3] 40–50 | 80–85 | 2–3 weeks | 31.3 | 92.6 | .94 |
| Mushrooms | 32 | 90 | 3–4 days | 30.4 | 91.1 | .93 |
| Okra | 45–50 | 90–95 | 7–10 days | 28.7 | 89.8 | .92 |
| Onions (dry) and onion sets | 32 | 65–70 | 1–8 months [4] | 30.6 | 87.5 | .90 |
| Onions, green | 32 | 90–95 | ---- | 30.4 | 89.4 | .91 |
| Parsley | 32 | 90–95 | 1–2 months | 30.0 | 85.1 | .88 |
| Parsnips | 32 | 90–95 | 2–6 months | 30.4 | 78.6 | .83 |
| Peas, green | 32 | 90–95 | 1–3 weeks | 30.9 | 74.3 | .79 |
| Peppers, chili (dry) | [3] 32–50 | 60–70 | 6 months | ---- | 12.0 | .30 |
| Peppers, sweet | 45–50 | 90–95 | 2–3 weeks | 30.7 | 92.4 | .94 |
| Potatoes, early-crop | [5] | 90 | [5] | 30.9 | 81.2 | .85 |
| Potatoes, late-crop | [5] | 90 | [5] | 30.9 | 77.8 | .82 |
| Pumpkins | 50–55 | 70–75 | 2–3 months | 30.5 | 90.5 | .92 |

See footnotes at end of table.

TABLE 11.—*Recommended temperature and relative humidity, approximate storage life, highest freezing point, water content, and specific heat for fresh vegetables in commercial storage*—Continued

| Commodity | Temperature | Relative humidity | Approximate length of storage period | Highest freezing point [1] | Water content | Specific heat [2] |
|---|---|---|---|---|---|---|
| | °F. | Percent | | °F. | Percent | B.t.u./lb./°F. |
| Radishes, spring | 32 | 90–95 | 3–4 weeks | 30.7 | 94.5 | 0.96 |
| Radishes, winter | 32 | 90–95 | 2–4 months | ---- | ---- | ---- |
| Rhubarb | 32 | 95 | 2–4 weeks | 30.3 | 94.9 | .96 |
| Rutabagas | 32 | 90–95 | 2–4 months | 30.1 | 89.1 | .91 |
| Salsify | 32 | 90–95 | ----do | 30.0 | 79.1 | .83 |
| Spinach | 32 | 90–95 | 10–14 days | 31.5 | 92.7 | .94 |
| Squashes, winter | 50–55 | [4] 50–75 | ([3]) | 30.5 | 85.1 | .88 |
| Squashes, summer | 32–50 | 90 | 5–14 days [3] | 31.1 | 94.0 | .95 |
| Sweetpotatoes | [3] 55–60 | 85–90 | 4–6 months | 29.7 | 68.5 | .75 |
| Tomatoes, mature-green | [3] 55–70 | 85–90 | 1–3 weeks | 31.0 | 93.0 | .94 |
| Tomatoes, firm-ripe | 45–50 | 85–90 | 4–7 days | 31.1 | 94.1 | .95 |
| Turnips | 32 | 90–95 | 4–5 months | 30.1 | 91.5 | .93 |
| Turnip greens | 32 | 90–95 | 10–14 days | 31.7 | 90.3 | .92 |
| Watercress | 32–35 | 90–95 | 3–4 days | 31.4 | 93.3 | .95 |

[1] Highest freezing points are from Whiteman (*739*).
[2] Specific heat above freezing was calculated from Siebel's (*600*) formula: S=0.008 (percent water in food) +0.20.
[3] See text.
[4] See text for variety differences.

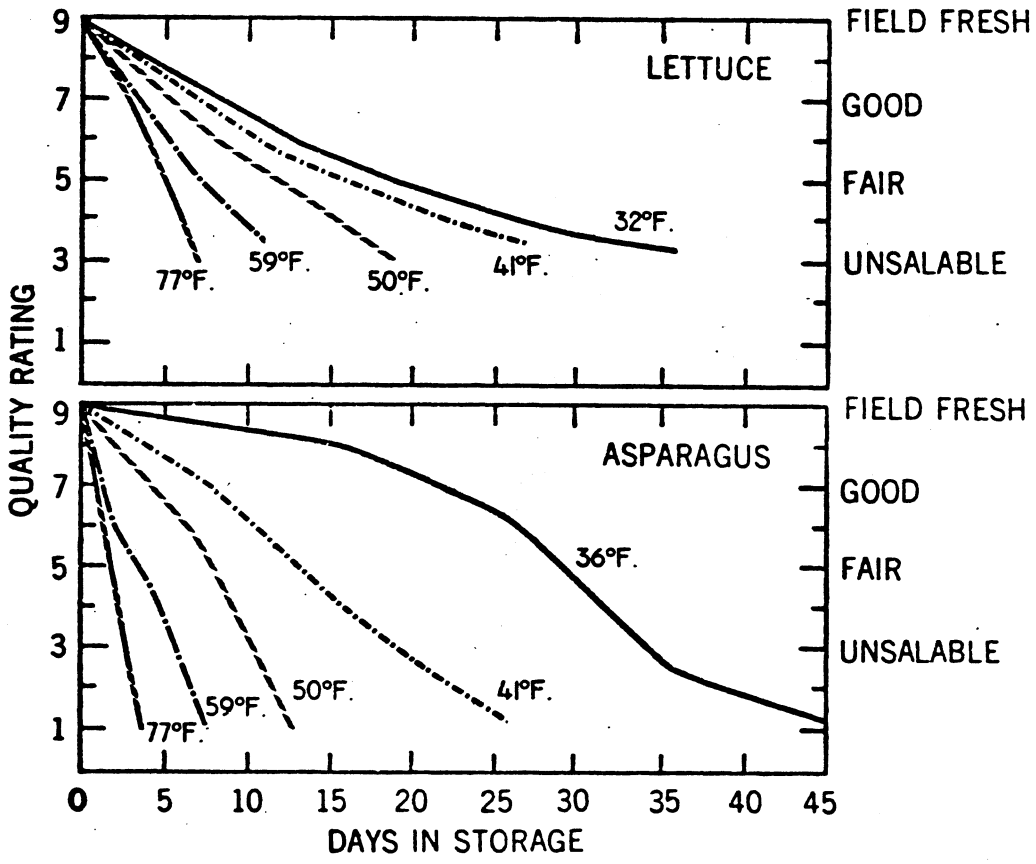



FIGURE 4.—Quality rating of asparagus and untrimmed lettuce stored at five temperatures for various number of days.